1831 1959

THE ADVANCEMENT OF SCIENCE

VOL. XVI No. 63 DECEMBER 1959

Editorial Committee
Dr. H. HAMSHAW THOMAS, M.B.E., F.R.S. (*Chairman*)
Prof. L. F. BATES, F.R.S., Prof. L. DUDLEY STAMP, C.B.E., Dr. W. E. SWINTON

CONTENTS

PAGE

OFFICERS AND COUNCIL OF THE BRITISH ASSOCIATION 155

THE ECONOMICS OF THE WELFARE STATE IN BRITAIN, *by* André Gabor . 157

INTERNATIONAL AIR TRANSPORT PROBLEMS, *by* Sir William P. Hildred, C.B., O.B.E., M.A. 165

ASSEMBLY OF CORRESPONDING SOCIETIES, 1959: A REPORT . . . 187

SEEBOHM ROWNTREE'S CONTRIBUTION TO THE STUDY OF POVERTY, *by* R. W. Drinkwater 189

THE PSYCHOLOGY OF LUCK, *by* Professor John Cohen . . . 197

LIVING WITH SCIENCE, *by* The Countess of Albemarle . . . 205

THE INFLUENCE OF PATHOGENIC FACTORS IN THE ROOTING SPACE ON THE DEVELOPMENT OF EVEN-AGED PLANTATIONS, *by* W. R. Day . . 212

SCIENTIFIC FILMS 227

SEISMOLOGICAL INVESTIGATIONS 1959 229

GENERAL TREASURER'S STATEMENT AND ACCOUNT, 1958–59 . . . 233

COUNCIL'S REPORT TO THE GENERAL COMMITTEE, 1958–59 . . . 240

SECTIONAL TRANSACTIONS AND REFERENCES TO PUBLICATION . . . 267

OFFICERS FOR THE YORK MEETING, 1959 307

DICTIONARY OF PHYSICS

Edited and Compiled by

H. J. Gray C.M.G. M.SC. LL.B. M.P.A. A.Inst.P.

With contributions from a number of leading scientists

. . . a sound, attractive compendium that will give good service to scientists, engineers, teachers and students . . .' *Scientific American* *84s net*

HISTORY AND PHILOSOPHY OF SCIENCE

L. W. H. Hull M.A.

Fundamental scientific ideas are fully discussed in order that their influence and dependence on thought in general may be fully understood.

'. . . lucid, accurate in its facts and reliable in its judgements.'

Times Literary Supplement *25s net*

Electrical Engineering Series

Edited by F. T. CHAPMAN

RADIO COMMUNICATION

W. R. Lovering M.S. M.I.E.E.

Based upon lectures delivered to H.N.C. and B.Sc.(Eng.) students, this book presents the fundamentals of radio communication theory.

'. . . an excellent course . . .' *The Times Educational Supplement* *60s net*

A GUIDE TO FRESHWATER INVERTEBRATE ANIMALS

T. T. Macan M.A. PH.D.

A key to the identification of freshwater animals, enabling the reader to identify to the nearest group, (usually the family) and, with the assistance of the extensive reference section, find the species. (Over 200 illustrations, most of which have been specially drawn for this textbook.)

'. . . a welcome addition to the meagre literature on British freshwater fauna.'

New Scientist *11s 6d*

LONGMANS, GREEN & CO LTD

6/7 Clifford Street · London W 1

OFFICERS AND COUNCIL OF THE BRITISH ASSOCIATION, 1959

PATRON

HER MAJESTY THE QUEEN

PRESIDENT, 1959

SIR JAMES GRAY, C.B.E., M.C., F.R.S.

PRESIDENT-ELECT

SIR GEORGE THOMSON, F.R.S.

GENERAL TREASURER

LORD RENNELL OF RODD, K.B.E., C.B.

GENERAL SECRETARIES

DAME KATHLEEN LONSDALE, D.B.E. F.R.S. — Dr. W. E. SWINTON

ORDINARY MEMBERS OF THE COUNCIL

Dr. D. A. ALLAN, C.B.E.
J. N. L. BAKER
Prof. R. J. BROCKLEHURST
Dr. H. O. BULL
Prof. W. BURNS
P. RITCHIE CALDER, C.B.E.
Prof. G. R. CLEMO, F.R.S.
Prof. P. SARGANT FLORENCE, C.B.E.
Prof. T. N. GEORGE
Sir RONALD GOULD
Prof. L. HUNTER
Rev. Prof. E. O. JAMES
Prof. D. L. LINTON
JAMES MACDONALD, C.B.E.
Dr. D. C. MARTIN
Dr. B. J. MASON
Dr. H. G. MAULE
L. R. MISSEN, C.M.G., M.C.
Lord NETHERTHORPE
Dr. K. P. OAKLEY, F.B.A.
Dr. R. W. POWELL
Dr. H. G. SANDERS
Prof. O. A. SAUNDERS, F.R.S.
Dr. R. E. SLADE
Sir EWART SMITH, F.R.S.
Dr. C. J. STUBBLEFIELD, F.R.S.
Dr. W. B. TURRILL, O.B.E., F.R.S.
Prof. G. C. VARLEY
Dr. N. A. B. WILSON
Prof. T. WILSON, O.B.E.

EX-OFFICIO MEMBERS OF THE COUNCIL

Past-Presidents of the Association, the President for the year, the President and Vice-Presidents for the ensuing Annual Meeting, past and present General Treasurers and General Secretaries, and the Local Treasurers and Local Secretaries for the Annual Meetings immediately past and ensuing.

PAST PRESIDENTS OF THE ASSOCIATION

H.R.H. THE DUKE OF WINDSOR, K.G., F.R.S. (1926)
Sir HENRY DALE, O.M., G.B.E., F.R.S. (1947)
Sir JOHN RUSSELL, O.B.E., F.R.S. (1949)
Sir HAROLD HARTLEY, G.C.V.O., C.B.E., M.C., F.R.S. (1950)
H.R.H. THE PRINCE PHILIP, DUKE OF EDINBURGH, K.G., K.T., C.B.E., F.R.S. (1951)
Prof. A. V. HILL, C.H., O.B.E., F.R.S. (1952)
Sir EDWARD APPLETON, G.B.E., K.C.B., F.R.S. (1953)
Lord ADRIAN, O.M., F.R.S. (1954)
Sir ROBERT ROBINSON, O.M., F.R.S. (1955)
Sir RAYMOND PRIESTLEY, M.C. (1956)
Prof. P. M. S. BLACKETT, F.R.S. (1957)
Sir ALEXANDER FLECK, K.B.E., F.R.S. (1958)

PAST GENERAL OFFICERS OF THE ASSOCIATION

M. G. BENNETT
Prof. P. G. H. BOSWELL, F.R.S.
Prof. Sir DAVID BRUNT, F.R.S.
Sir HAROLD HARTLEY, G.C.V.O., C.B.E., M.C., F.R.S.
Dr. EDWARD HINDLE, F.R.S.
Sir BEN LOCKSPEISER, K.C.B., F.R.S.
Sir FRANK SMITH, G.C.B., G.B.E., F.R.S.
Sir RICHARD SOUTHWELL, F.R.S.
Prof. F. J. M. STRATTON, O.B.E., F.R.S.
Dr. G. TAYLOR
Dr. N. C. WRIGHT, C.B.

HONORARY AUDITORS

Dr. D. B. HARDEN, O.B.E. — Dr. H. G. MAULE

SECRETARY

Sir GEORGE V. ALLEN, C.B.E.

An exciting new colour called tricycle

What more can a man ask than a sunny day, something that has to be painted . . . and, of course, plenty of paint. Obviously a job as important as this calls for a very special colour, and that might take a lot of mixing.

The manufacture of paint and surface coatings is a big job. Large quantities of solvents are needed for the production of the many different types of coatings for metal, wood, paper and fabric — and for protective and decorative purposes. Shell Ketone, Alcohol, Glycol Ether and Aromatic Hydrocarbon solvents all play their parts in helping to provide the quality required in the finished product — by improving the solids content, flow and gloss or by combining these properties. Shell's new 'Epikote' synthetic resins have also made an outstanding contribution to the higher quality and performance of industrial finishes for a wide range of applications, from toothpaste tubes to aircraft bodies.

Can Shell Solvents or 'Epikote' resins assist you in your production? They probably can. In fact, if you have any problems concerning the manufacture of surface coatings — or the use of chemicals, industrial or agricultural — Shell may well be able to help you. You can easily find out.

Write to the Sales Promotion Manager, Shell Chemical Company Limited, Marlborough House, 15-17 Gt. Marlborough Street, London, W.1.

YOU CAN BE SURE OF SHELL CHEMICALS SHELL

THE ECONOMICS OF THE WELFARE STATE IN BRITAIN[1]

by

ANDRÉ GABOR

Department of Economics, The University of Nottingham

I. Outline of the Financial Aspects of the Social Services

Britain provides an impressive array of completely or partly subsidised services, certain selections of which are often referred to under the name of the Welfare State. Whether this identification is correct or not is a question which I propose to discuss a little later; for a start let us look at the more material side of what government publications describe as the Social Services.

The main headings of the official list are (i) Education, (ii) Youth Services, (iii) Employment, (iv) Health, (v) Housing and Planning, (vi) National Insurance and related services, (vii) Judicial Administration, and (viii) Voluntary Organisations (1). Though several independent observers do not consider this enumeration entirely correct, they agree in respect of those items which account for the bulk of the expenditure, hence their proposed amendments may be disregarded while we discuss the broad outlines of the financial aspects of this particular collection of the social services.

The layman might think that all one has to do to ascertain the current cost of a public activity is to turn up the relevant statistics. Unfortunately, this is not so. Published statistics inevitably lag behind the events which they describe, and where relatively recent information is available, it is seldom in the required detail (2). Experience has shown that even the discovery of the true past cost of any of the larger social services is a sizeable research project because the results do not emerge ready-made from official records but have to be painstakingly compiled by analysing and combining data from a large number of sources (3). This is why, in my effort to arrive at reasonably up-to-date figures I had to rely largely on estimates, and the fact that some of them came from official quarters does not mean that they may not be subject to considerable error. However, I hold with Professor Wildon-Carr's motto, according to which it is better to be vaguely right than precisely wrong. Besides, since the items in question are subject to constant change, what should interest us is not so much the precise amount as rather the order of magnitude and the broad trend of the cost involved, and I am inclined to think that both of these can be discerned with sufficient accuracy for our momentary purpose.

At present the total current expenditure on social services may be estimated to run at the rate of about £3,000,000,000 per annum, and this is so large a figure that we cannot readily appreciate its proper significance except in relationship with other relevant statistics. Perhaps it will become more understandable if I say that it represents an annual charge of approximately £60 per head of the population.

Since the number of personal incomes is only about half the number of the total population, the average burden on incomes is twice as large as the figure just mentioned. But it would be rash to conclude that if the social services were abolished, the average income receiver would have an extra £120 at his disposal for

[1] Paper delivered to Section F (Economics) on Monday, September 7, 1959, at the York Meeting of the British Association.

current expenditure of his own choice. (To mention one reason only, a not inconsiderable proportion of personal incomes arises out of the expenditure on the social services themselves.) The figure is useful only in so far as it helps us to understand the significance of the social services in Britain's economy.

Another way in which we can assess the relative magnitude of the bill annually presented is this: on the average, out of every £100 currently spent on goods and services by consumers and public authorities approximately £16, that is to say almost one-sixth, is current expenditure on social services.

Apart from voluntary contributions, which we may leave out of account here, the social services receive their current finance from three main sources: (i) charges, that is to say payments extracted from the recipients of not fully subsidised services, (ii) statutory contributions of insured persons and employers to the National Insurance Fund, and (iii) contributions of public authorities over and above what they pay as employers.

Overwhelming is the share of the public authorities, which amounts to about two-thirds of the total. The social services receive the money from organs of central and local government, which means that it is in fact a burden on taxpayers and ratepayers. Some people might think that this interpretation is not quite correct, in so far as not all government revenue arises out of taxation. For example, the Post Office yields a modest surplus, so do the Crown Lands and some of the Public Corporations, and certain trading activities of local government, such as water supply and transport are also conducted on a commercial basis. At the moment these provide a relatively slight proportion of revenue only, but both the extent and the profitability of these sources could conceivably be expanded, and if government expenditure were not allowed to increase *pari passu*, this could lead to appropriate reductions of taxes. If now, say, half the revenue of central and local government came from the ownership of productive resources and trading activities would it still be right to maintain that all government expenditure was a burden on the taxpayer?

There is a twofold answer to this question. First, if the expenditure concerned were discontinued, it would be possible to reduce taxation by the same amount. Second, and this is more fundamental, the profits derived from public enterprise or ownership are tantamount to an indirect tax on the good or service supplied. The truth of this is easy to see if we imagine that tobacco products, say, are made a state monopoly (which they are in some other countries), but it is decided to leave selling prices unchanged. It would then make no difference whatever if, at any later date, the tobacco duty were abolished, since as long as the excess of the price over cost remained the same, the purchaser of a packet of cigarettes would contribute an unchanged amount to government revenue. And the person who buys cigarettes is a taxpayer, even if, for one reason or another, he never paid a penny income tax in his life.

We should note here that this argument does not involve any moral or political issue. It does not follow from it that a public enterprise or a nationalised industry should make no profits, because this is an entirely separate question. What we learn from it is simply that just as any loss made good from government funds amounts to a subsidy, so is any net profit pocketed by the government an indirect tax. I will come back to this point in connection with existing and proposed investment policies of the National Insurance Funds.

So the share of the public authorities is of the order of £2,000,000,000, or not much less than the estimated yield of income tax in the financial year 1959–60. It accounts for roughly a third of the combined current expenditure of central and local government, including the National Insurance Funds.

The other two main sources from which the social services are financed, namely charges and contributions of insured persons and employers, provide about

£1,000,000,000, probably a little more. The overwhelming proportion of this comes from contributions, some 80 per cent or so.

It is rightly claimed, I think, that even though these contributions could be called insurance premiums, they are in fact taxes. The employers' share is an indirect tax, levied on the services of employed labour, whereas under the existing system the contributions of insured persons act as a poll tax graduated according to the category of the subject but not according to his income. (The new system, embodied in the National Insurance Act 1959, will provide for roughly proportionate contributions within a narrow range.)

Serious critics of the present method have argued that contributions of the type levied at present are iniquitous and harmful to the public interest. Some of them propose a separate progressive social security tax, others are in favour of making the contributions an indistinguishable part of general taxation (4). I myself have great sympathy with this idea and consider it a pity that it was not introduced in 1946 when the whole system was re-cast into its present form. I do not believe, what is often argued, that people prefer to pay for their retirement pensions and other benefits. After all, experience has shown how highly esteemed those pension schemes are which, like the one enjoyed by the Civil Service, do not extract any contributions from the beneficiaries. Human nature is such that we like to think that we are getting something for nothing, at least as long as it does not smack of charity.

It has also been said that the contributory system helps to maintain the actuarial basis of the National Insurance Funds, but this again is an argument with which I have little sympathy. Let us look the problem squarely in the face. The actuarial basis of private life insurance means that what is left of the premiums after current administrative costs are covered is invested, and the premiums are so calculated that the principal and accumulated interest of the investments provide full cover for the estimated liabilities of the company. This is a perfectly reasonable system for private insurance schemes, but not for national insurance funds. If, as at present, the annual surplus, if any, is invested in government securities, the payment of the interest and, in fact, the repayment of the principal is just a burden on the taxpayer. The answer seems to be to invest the surplus in good securities issued by companies in the private sector, and this has in fact been proposed, but here we must remember that the argument I mentioned earlier according to which profit paid into the coffers of the government is an indirect tax is entirely independent of the extent to which the capital is owned by public authorities and applies with equal force whether or not public control is exercised over the conduct of the company concerned. This means that the issue is of a political character which the economist *qua* economist may analyse but cannot decide, hence I will say no more of it.

There is, however, one further point which the economist may and I think should make, and it is this: no financial juggling can hide the fact that each generation has to care for its own dependants. What is consumed by people who are too young or too old to work and by those who are incapacitated for other reasons must come out of the current output of the nation. There is, therefore, much to be said for national insurance schemes which do not attempt to build up funds but balance current income and expenditure. Though not originally conceived on this basis, this is in effect how the National Insurance Fund of this country is expected to operate in the future, because although a relatively small annual amount of £50 million is envisaged as income from past investment in government securities, no further surplus of any significance is being contemplated. I feel that it should be appreciated more widely by the insured that their right to pensions and other benefits is not based on accumulated savings but rather on the fact that, during their working life, they contributed towards the maintenance of the nation's dependants.

I do not propose to say much about the annual rate at which capital is invested in the social services. It appears to be of the order of £400 million, but since

investment both inside the social services and in other fields tends to fluctuate within relatively wider limits than current outlay, the significance of the fact that at present some 11 per cent of the total investment by the nation is devoted to the purposes of the social services should not be overrated.

II. The Weight of the Burden on the Community

In the foregoing I attempted to sketch a rough outline of the expenditure and finances of the Social Services. We have seen the size of the burden the community has to bear directly or indirectly, now it is time to consider its weight and its rate of change.

To put it simply, the question is whether the social services as they exist today and as they are expected to develop in the near future are on a reasonable scale or too lavish in view of the general economic conditions of the country. We have seen that the current cost claims about 16 per cent of day-to-day expenditure at home, and I may add to this that if we take current and capital expenditure together, and relate it to the value of the gross national product, we find that the proportion is over one-sixth or approximately 17 per cent. Perhaps I should mention in parentheses that the value of the gross national product is defined as home expenditure and investment at market prices plus subsidies and exports, *less* imports and indirect taxes. It equals the national income of the country, before any allowance for the depreciation of capital assets. This appears to be the correct basis for getting the total cost of the social services into proper perspective.

The items which seem to have given rise to most concern are the present cost of the National Health Service and the future burden of retirement pensions paid to the increasing army of men over 65 and women over 60.

In respect of both of these expert opinion, which was largely pessimistic during the first post-war years, is now fairly optimistic. When Abel-Smith and Titmuss investigated the trend of the net cost to public funds of the National Health Service from its inception in 1948 down to 1954, they found that although the cost was rising at the rate of about 3·5 per cent per annum, there was no need to worry because the value of the gross national product was increasing at a higher rate (5). This seems to have silenced the critics for the time being, especially since more recent developments appear to confirm the experience of the earlier years. The present net cost to public funds is probably about £580 million, which is only four-fifths of the yield of the tobacco duty.

But what about the ageing population? People have actually been frightened into emigration at the thought of the future in a country where, according to some gloomy forecasts, a dwindling labour force will be taxed more and more heavily to keep a lot of useless old people in comfort. Some of the more despondent prophets also impressed on us the view that the growth of world population tends to exceed the increase in food production, that exportable surpluses will therefore disappear and a country like Britain, which has to import half of its food, will soon be at the verge of starvation.

More recent trends have belied these dismal prophecies and largely silenced the people who uttered them. We are now told that although world population is rising and a very large proportion of it is underfed by Western standards, no overall deterioration has taken place and also that the possibilities of increasing food production are much greater than was formerly believed.

Nearer home the situation is that, according to prevailing opinion, the more or less imminent fall in population and the concomitant gross distortion of the age structure, so confidently forecast by the experts, is nowhere in sight. Since I consider my own powers of discerning the future extremely limited, I will refrain from prophecy and just quote some of the figures which I calculated on the basis

of the information provided by the Government Actuary and the Registrars-General, which has not to my knowledge been so far challenged by any serious observer.

The latest estimates which were at my disposal when this paper was written give quinquennial figures of the age structure of the population of the United Kingdom from 1957 to 1997 (6). During these forty years an overall rise of almost 12 per cent is expected to take place, while the total potential labour force, defined as males over 14 and under 65 and females over 14 and under 60 will rise by 10 per cent only. The most critical period seems to come with the years around 1982, when the labour force, which was 62·5 per cent of the total population in 1957, will fall to 60 per cent.

Clearly, this is very far from serious, because, to leave present standards unchanged, a rise of 4·25 per cent in the productivity per worker would suffice. Since we have reason to believe that the actual increase in productivity could easily exceed 50 per cent in the course of the twenty-five years concerned, there seems to be ample room left for a substantial improvement in the standard of living (7).

We also have some useful figures provided by the Government Actuary in respect of present and future income and expenditure of the National Insurance Fund (8). The total expenditure estimated at £935 million for 1959–60 is expected to rise to £1,397 million by 1981–2. Per head of population this corresponds to a rise from £18 to £25, and in terms of the gross national product per head to a rise of 2·2 per cent in twenty years, which is reassuring. The discrepancy between this figure of 2·2 per cent and 4·25 per cent derived from the expected change in the age structure of the population is more apparent than real. The larger figure is based on the rise of the proportion of all dependants, hence it relates to the increase of the total burden on the labour force, while the smaller figure refers to that part only which is administered by the National Insurance Fund. It should be stressed that both figures are estimates based on definite assumptions which may not prove correct. However, they could not be called alarming even if a 50 per cent safety margin were added to them.

Before the end of the Second World War, and for some time after, fears were expressed that unemployment will upset the balance of the National Insurance Fund, but the spectacularly low and only mildly fluctuating unemployment rate of the last fourteen years has silenced most pessimists. We now believe that we know how to avoid the recurrence of major depressions, and this has also helped to make people more confident of the future. Beveridge, who in 1942 thought it necessary to assume an average rate of unemployment of 8·5 per cent, reduced his estimate to 3 per cent in 1944. At the time many people thought that this was far too optimistic; nowadays we tend to agree with Beveridge, who called it a conservative rather than an unduly hopeful forecast. Even Government circles adopted it, albeit not until October 1958.

The upshot is that, provided we accept the present position, we need not unduly worry about the trend of the cost of the social services. There are, however, people like Professor Wilhelm Röpke and, nearer home, Mr. Colin Clark, to mention two distinguished economists only, who warn us that the burden of taxation swelled by the claims of the social services may not be possible without constant inflationary pressure (9). The strictures of the critics are not on the financial aspects alone. Röpke asserts that the freedom of the economy is endangered by forcing crutches on the community which it is then unable to discard.

The Central Office of Information takes a different view. In its Reference Pamphlet on *Social Services in Britain* it tells us that 'None of these services was imposed by the State upon an unwilling public. All of them were the result of co-operative effort by the successive Governments and the people whom they governed.' If we accept this statement, and it does seem to be widely accepted in

this country, then any freedom which the community sacrificed by entrusting to the public authorities the task of providing social services may be said to have been surrendered willingly. And it is, I think, generally recognised that in order to live in a happy community, the individual has to give up some of his liberties because, to quote the words of Tawney, 'freedom for the pike is death for the minnows' (10).

There is still the question of inflation. Is it true that unless Britain is prepared to reduce taxation to a substantial extent, which would hardly be possible without drastic reductions in the social services, inflation could not be conquered? I myself do not think that this is true, but I do believe that both the people and the government of this country could pay somewhat greater attention to what is perhaps the only unchallenged principle of economics, namely that you cannot have your cake and eat it. What it means is that Britain certainly can afford to maintain its social services but it must also be realised that every bit of the expenditure has to be met by not having something else which could otherwise have been provided. Only exceptionally is it possible to gain what Sir Dennis Robertson calls economies at the expense of the devil, that is to say, to relieve the private sector of a responsibility formerly carried and charge less for it than what it cost before. And even if this does happen, the danger is that it will whet the appetite for additional benefits which may dissipate the gain.

III. Wider Interpretation of the Welfare State

I hinted at the outset that although the Social Services tend to be referred to under the name of the Welfare State, this identification may not be correct. I will now go further and say that I myself do not agree with it because I am one of those who believe that the content of the Welfare State goes very much further than indicated by the type of activity which appears to merit the name of a social service. I will expand this argument, but first let us see how far the scope of the social services is supposed to extend.

It happens that there is no full agreement among social scientists as to the proper characteristic of a social service (11). The official attitude seems to be that a heading is defined by the list of items which follow it, but this is hardly satisfactory from a more fundamental point of view. To make it worse, the lists which we find in different government publications are not invariably identical, and there are social scientists who refuse to accept any of them as correct. It seems to me that the problem is the same as that which confronted Abraham Lincoln when, acting as a lawyer, he found that his opponent and himself were talking at cross purposes. 'Let us leave this for a moment,' said Lincoln, 'and permit me to ask you a simple question. How many legs has a cow?' 'Four,' came the surprised answer. 'Now suppose that we call the cow's tail a leg, how many legs would the cow have then?' 'Why, five, of course,' said his adversary. 'This is exactly where you are wrong,' retorted Lincoln, 'because *calling* a cow's tail a leg does not make it one!'

According to some academic critics, the official lists of the social services represent more or less arbitrary collections of legs and tails. They realise the difficulties of drawing a clear-cut division through the maze of public activities, but they say that the line has to be drawn, if only to delineate the proper scope of their interests.

The view has been advanced that the main criteria of a social service are that it is not run on a profit-making basis and that it is intended to compensate existing inequalities but, as it has been shown by Miss Eyden (12), definitions based on these characteristics will not stand closer examination. She proposes to describe a social service as the work of a social institution designed to meet the personal needs of individuals not adequately met by resources of their own or their family or by commercially run concerns. This seems to be a good working definition for the purposes

of the social scientist, even though, as pointed out by Titmuss, the definition of a need itself changes with time and place and 'social' and 'individual' are interdependent, mutually related aspects of the whole. According to him, 'all collective interventions to meet certain needs of the individual and/or to serve the wider interests of society may . . . be broadly grouped into three major categories of welfare: social welfare, fiscal welfare and occupational welfare'. He then calls these three categories the 'three different systems of social services' and implies that they embrace the full scope of 'The Welfare State' (13).

To my mind, even this interpretation is not wide enough, because although Titmuss does not define what exactly he means by 'collective interventions', his analysis indicates that he must have had a limited range of the actions of public authorities in mind. He would probably be prepared to make room for certain voluntary non-profit-making organisations, but hardly for those inventors, technologists and successful businessmen who have brought the luxuries of former generations within the reach of the majority of the nation.

To take my points in turn, my first objection is that in a country like Britain *all* the proper activities of public authorities are aimed at the welfare of the nation and since I agree with Titmuss that 'the definition, for most purposes, of what is a "social service" should take stand on its aims', I can see no reason why any part of the work of central and local government should be excluded from the Welfare State. Please note that I referred to the welfare of the nation, without any mention of individual needs. The reason why individual needs may be disregarded is that if the community, acting through its public authorities, provides any service to an individual, the relevant motive is the satisfaction of the communal wish that this should be done. Hence any comment to the effect that a particular action of this type was willed by the community even though the satisfaction of the need of the individual concerned was indifferent or even inimical to its welfare would be self-contradictory.

My second point concerns the meaning attributed to the word 'State' in this context. According to the dictionary, it may mean, among many other things, 'the whole body of citizens as a corporation represented by the administration for the time being', and this appears to be the sense in which Titmuss and many other learned commentators of the Welfare State use it. I think that another meaning, also listed in the dictionary is the proper one here: '*the State is an organised political community with government recognised by the people*'.

To put it in other words: welfare is indivisible. It may be correct to judge the activities of the public authorities by their aims, but the community itself is interested in achievements, and if general welfare has made appropriate progress in this country, the proper thing to say is that Britain *is* a Welfare State, and not that it has one.

References

(1) Cf. *Social Services in Britain* (C.O.I. Reference Pamphlet), H.M.S.O., 1958. I omitted Section (ix), which deals with the training for social work, because it is part of the educational services listed under (i).

(2) Once a year the *Monthly Digest of Statistics* (H.M.S.O.) provides information about expenditure by public authorities on the social services. The latest figures, contained in the May 1959 issue, are estimates in respect of the financial year which ended on April 5, 1959.

(3) The fundamental difficulties are outlined by W. A. B. Hopkin in his introduction to Abel-Smith, B. & Titmuss, R. M., *The Cost of the National Health Service*, University Press, Cambridge, 1956, p. xvii.

(4) For a summary of the main arguments and propositions, cf. Peacock, A. T., *The Economics of National Insurance*, William Hodge & Co., London, 1952, pp. 89 ff.

(5) Abel-Smith & Titmuss, *loc. cit.*, p. 168 and *passim*.

(6) *Annual Abstract of Statistics*, No. 95, H.M.S.O., 1958.

(7) Cf. Hagenbuch, Walter, *Social Economics* (Cambridge Economic Handbooks Series), James Nisbet & Co., Cambridge, 1958, p. 50. His conclusions are based on slightly less recent data.

(8) Cf. *National Insurance Bill*, 1957, *Report by the Government Actuary on the Financial Provision of the Bill*, Cmnd. 294, H.M.S.O. 1957, p. 7, and *Provision for Old Age*, Cmnd. 538, H.M.S.O. 1958, p. 23.
(9) RÖPKE, WILHELM, *Welfare, Freedom and Inflation*, Pall Mall Press, London, 1957.
(10) TAWNEY, R. H. *Equality*, Harcourt Brace & Co., New York, 1931, p. 220.
(11) Cf. e.g. TITMUSS, R. M., *Essays on 'The Welfare State'*, George Allen & Unwin, London, 1958, especially, pp. 40–42, and JOAN EYDEN, 'Social Services in the Modern State', *Can Conference*, Vol. 1, No. 10 (February 1955), pp. 16–21.
(12) EYDEN, *loc. cit.*, especially pp. 16–18 and 21.
(13) TITMUSS, *loc. cit.*, pp. 39, 42 and 53.

INTERNATIONAL AIR TRANSPORT PROBLEMS[1]

by

SIR WILLIAM P. HILDRED, C.B., O.B.E., M.A.

INTRODUCTION

THIS paper will not be about the science of aeronautics: that has become the province of some twenty-odd varieties of scientific specialities; and I do not profess any one of them. I would like, however, to say something about the business of applying scientific knowledge and discovery to peaceful human use in a complicated field of social relationships, perhaps the most challenging field of science in our generation.

A review of the general development of international air transport comes at an appropriate moment. We are just completing the first forty years of scheduled commercial air transport, and only a few days ago we passed the fortieth anniversary of the founding of the International Air Traffic Association as the agency for international co-operation in transport aeronautics.

These forty years can be divided into two twenty-year periods. From 1919 to 1939, we took the primitive aeroplane which the First World War had given us and put it to work in a rudimentary way in peaceful commerce. From 1939 to 1959, we have applied the tremendous technological developments of the second world air war to the carrying of larger burdens over longer ranges at greater speeds and come at last into the era of jet transport.

THE GROWTH OF AIR TRANSPORT

There are so many statistics in the world of today that I hesitate to add to them but a few figures must, of necessity, creep into the picture. Figures do show the tremendous expansion of air transport during those forty years. To give an example without figures I would say that the smallest inter-city helicopter operator among I.A.T.A.'s members carries today ten times as many passengers as all the members of I.A.T.A. did in 1920. Many of our airlines today carry as much in a year as all the members of I.A.T.A. did in 1938.

The development of the first two decades was slow, but steady. In 1920, aircraft had an effective range of about 300 miles and a speed of about 85 m.p.h. Their payload capacity was about 800 lb. They could work about 300 hours a year and spent nearly half their time in the hangar for repairs. After dark and in the winter season, which meant six months, they did virtually no flying at all.

But by the time of that outrage, the Second World War, aircraft had developed into something resembling the sleek, silver-skinned monoplanes of today. Their speed had increased to 185 m.p.h., their range to 1,000 miles and their all-up weight to 25,000 lb. They were flying the year round, flying at night and flying blind. The services of the airlines had reached out to link Europe with Asia, Africa and Australia; there were extensive systems in North and South America and the first links over the oceans between the two hemispheres were being forged. But I remind myself that even in 1941 when I flew to Vancouver, Trans-Canada only had one aeroplane which could climb the Rockies. So we flew

[1] Text of an Evening Discourse delivered by Sir William Hildred, Director General of the International Air Transport Association, on Monday, September 7, 1959, at the York Meeting of the British Association.

to the foot of the Rockies and waited at Lethbridge for the one Lodestar which had the necessary power to get over the mountains.

The development of air transport since the end of World War II has been phenomenal. The demands of the war years and the enormous needs of reconstruction in many parts of the world combined to create an unprecedented requirement for air transport. That war had left a legacy of improved transport aircraft in large numbers and what seemed at the time an almost bottomless reservoir of aggressive trained flying personnel. Moreover, the forced draft of scientific research and technological development of the war years provided the basis for a continuous improvement in the performance of aircraft and their related services which is still in progress.

The result in terms of the work performed by the scheduled airlines of the world will be found in Appendices 1 and 2, which I am attaching to this address. The curves set down there will, I think, be more expressive than any verbally stated comparisons. A few million passengers carried in 1946, 90 million last year; 900 million kilometres flown in 1946, 3,000 million last year. In 1958 the scheduled airlines carried more passengers across the North Atlantic route alone than the whole membership of I.A.T.A. carried anywhere in 1938.

The implications of that progress in terms of the airlines and the aircraft they operate can be read from Appendices 4 and 5. Revenue passenger kilometres: ten thousand million in 1946, 70,000 million in 1957. Operating revenues up from 1,000 million dollars in 1946 to 4,000 million dollars in 1958. But by the same token, operating expenses up from 1,100 million dollars in 1946 to 4,360 million dollars in 1958. 1958 reveals an overall operating deficit of 160 million dollars. The safety figures show a reduction from 3 fatalities per 100 million passenger kilometres down to 0·4 fatalities per 100 million passenger kilometres. These figures are based on the experience of the I.A.T.A. membership. Not all international airlines are in I.A.T.A. But most of them are. I.A.T.A. members account for a steady 90 per cent of all scheduled traffic throughout the world (excluding the U.S.S.R. and the People's Republic of China). What has happened within the framework of I.A.T.A. is by and large the story of what has happened to the whole of air transport.

With the discovery of new potentialities for the aircraft and the creation of new states, the number of airlines has grown tremendously. To give an example there are over 60 domestic airlines in Colombia.

Figures, of course, tell only part of the story. More is to be found on the map and I have not yet seen a map big enough to show all the air routes of the world in their detailed intensity and complexity. But the picture would not be complete unless one visualises a network of services around the globe, spanning all of the oceans and connecting many thousands of cities on all the continents with an almost infinite number of possible routings. But the real story is with the man behind the figures.

This network, over which traffic shuttles ceaselessly and in daily increasing volume, constitutes one of the facts of modern life. It has become a cliché to say that the airlines have shrunk the world, but it is true. There is literally nowhere in this world today which can be considered remote, or inaccessible. You can get anywhere from anywhere in less than 3 days. In a physical sense, mountains, seas, deserts and forests no longer constitute barriers to the movement of man and his goods. The world has become a single neighbourhood in which no man's fence can ever be high enough again to shut him away from a concern with the affairs of his fellows. In commercial terms, the services of air transport are now available at fares and rates which make then feasible as the normal, rather than the exceptional, means of movement for millions of persons of what is considered average income in many countries, and for the shipment of an immense variety of goods.

This progress has not come about without travail and difficulty. The pioneering of the world's air routes and the adventures of the body, mind and spirit which have made possible this expansion and accomplishment are a fascinating but separate story. The history of every airline is a saga in itself, replete with the deeds, decisions and sacrifices of brave and dedicated men. But my assignment is to concentrate on adventuring at a different level, in the co-operation between many airlines and many governments which has transformed the works of these individual enterprises into a world-wide network of effective public service.

Beginnings of International Organisation

In 1919, commercial air transport made its first beginnings. One pilot who was flying commercially in that year is now Lord Douglas of Kirtleside, Head of B.E.A., a pointer, if one were needed, to the short span of history we are discussing. The first European airline operators soon became aware that within the cramped confines of Europe, the aeroplane was inevitably a vehicle of international, rather than domestic transport. And they realised that this new vehicle had been born into a world which was mentally and commercially not ready for it. The problems of operating across international borders, under a régime which had been created for canal boats, stagecoaches, and railways, were too many and too complex for any single carrier to deal with alone. Therefore, the International Air Traffic Association of some half dozen operators was created at The Hague in 1919.

At the same time, Governments, no less conscious of the problems which the fledgling posed for an unready world, created two instruments of their own: I.C.A.N. (the International Convention on Aerial Navigation) to deal with matters of certification, rules of the air and the like; and C.I.T.E.J.A. (the International Technical Committee on Air Law) to handle the legal ramifications. Later a fourth leg was added to the table with the signing of the Warsaw Convention as the international rule for carriers' liability.

By present standards, this structure of international co-operation and regulation was rudimentary and even delightfully casual, but it worked well enough in an era when air transport was still largely regional and longer routes were few and thin. It worked until 1939, until the Second World War. Then everything civil closed down in the war areas. But in the closing years of the war, when it became possible to think about the resumption of peaceful air commerce, it was apparent to all concerned that the new potentialities of the aeroplane would burst every seam of this pre-war structure. There would clearly be much more flying by the aircraft of many more nations. Route structures would be infinitely more extensive and complex. There would be endless problems of certification. New rules of the air would be needed to fit new capabilities. New systems of air navigation facilities would have to be planned. Legal relationships and situations would be altered. The linking of the hemispheres over the North Atlantic, experimental in 1939 and a routine fact during the war, meant that two hitherto separate systems of air transport regulation and practice would have to be co-ordinated. And all of this would have to be worked out on the basis of global standardisation, so that no matter where the aircraft of any country might fly, they would fit without friction or risk into the traffic pattern and ground services they would encounter.

This realisation led to the calling of a Conference in the Stevens Hotel in Chicago in November 1944 of a world-wide Civil Aviation Conference. Fifty-two nations were present. There was created the International Civil Aviation Organisation, now a specialised agency of the United Nations, as successor to I.C.A.N. and C.I.T.E.J.A. Today, I.C.A.O. is the organ through which governments deal with the international problems of civil aviation.

At the same time and in the same hotel airline representatives who were members or advisers of their national delegations met in some of its bedrooms to lay the

foundation of a new I.A.T.A., which came formally into being at a subsequent meeting of the airlines in Havana in April 1945. Today I.A.T.A. is the organ through which the international airlines deal with their international civil aviation problems. There are thus two world-wide bodies, I.C.A.O. at the Government level and I.A.T.A. at the commercial level. It is I.A.T.A. which I serve, but I would like to describe briefly the functions of I.C.A.O. before going on to those of I.A.T.A.

The International Civil Aviation Organisation is based on the Chicago Convention, to which seventy-four states have now adhered, and that Convention is prefaced by this statement:

> WHEREAS the future development of international civil aviation can greatly help to create and preserve friendship and understanding among the nations and peoples of the world, yet its abuse can become a threat to the general security; and
>
> WHEREAS it is desirable to avoid friction and to promote that co-operation between nations and peoples upon which the peace of the world depends;
>
> THEREFORE the undersigned governments having agreed on certain principles and arrangements in order that international civil aviation may be developed in a safe and orderly manner and that international air transport services may be established on the basis of equality of opportunity and operated soundly and economically;
>
> HAVE accordingly concluded this Convention to that end.

The ninety-six articles of that Convention establish the privileges and restrictions of all contracting states, provide for the adoption, if Governments see fit, of international standards and recommended practices regulating air navigation, recommend the installation of navigation facilities by member states and suggest the facilitation of air transport by the reduction of customs and immigration red tape by member states.

The Convention accepts the principle that every state has complete and exclusive sovereignty over the airspace above its territory and it sets forth that no scheduled international air service may operate over or into the territory of a contracting state without its previous consent. Without acceptance of the principle of national sovereignty, there would have been no Convention.

The Chicago Conference went into the question of the exchange of commercial rights in international civil aviation. There was a head-on collision between the concept of unrestricted freedom of the air and of varying degrees of control. These concepts could not be reconciled but supplementary agreements were drawn up to which states could adhere if they saw fit. The first gave the right of innocent passage. A civil aeroplane could fly over a state and could land for refuelling or technical purposes in the territory of any signatory state. The second further provided for the carriage of traffic (passengers, cargo and mail) between the state of registration of the aircraft and any other signatory state. To date, thirty-three nations have signed the first and eleven have signed the second.

It was not possible to get a multilateral agreement on the exchange of commercial rights in Chicago. It was not possible when I.C.A.O. tried it again at Geneva in 1947. The result is that all agreements between states are in the nature of bilateral agreements—the first of which was the Anglo-American Agreement signed at Bermuda in February 1946.

I.C.A.O. has the following aims and objectives:

> To develop the principles and techniques of international air navigation and to foster the planning and development of international air transport so as to
>
> insure the safe and orderly growth of international civil aviation throughout the world;
>
> encourage the arts of aircraft design and operation for peaceful purposes;
>
> encourage the development of airways, airports and air navigation facilities for international civil aviation;

meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;
prevent economic waste caused by unreasonable competition;
insure that the rights of contracting states are fully respected and that every contracting state has a fair opportunity to operate international airlines;
avoid discrimination between contracting states;
promote safety of flight in international air navigation;
promote generally the development of all aspects of international civil aeronautics.

The governing body of I.C.A.O. is the Assembly, in which each state has a vote and which generally works by majority. Its executive body is the Council, composed of representatives of twenty-one states; and this Council has four subordinate bodies, the Air Navigation Commission, the Air Transport Committee, the Committee on Joint Support of Air Navigation Services and the Finance Committee. Also under the guidance of the Council is the Legal Committee, in effect the successor to the old C.I.T.E.J.A.

The main achievement of I.C.A.O. has been the formulation and adoption of fifteen Annexes to the Chicago Convention in which are kept up to date the international standards and recommended practices covering virtually every phase of the technical regulation of civil aviation. They are listed seriatim in Appendix 6, but a mere listing hardly conveys their importance, or the degree of international accord which they represent.

Each paragraph represents in effect a multilateral agreement among the member states of I.C.A.O., not only to recognise its content as the international desideratum, but also to implement it through its own national regulations. It is a commitment arrived at after close international study; first in divisional meetings of I.C.A.O., then in one of the Commissions; then by review in the I.C.A.O. Council; and finally by the approval of a majority of the individual states.

International Air Transport Association

I now turn to the International Air Transport Association which I serve as Director-General. The aims of this incorporated body are set forth in its Articles of Association and in the Act of the Canadian Parliament (9–10 George VI Chapter 51) which gives it legal life. Its aims are:

(*a*) to promote safe, regular and economical air transport for the benefit of the people of the world, to foster air commerce and to study the problems connected therewith;
(*b*) to provide means for collaboration among the air transport enterprises engaged directly or indirectly in international air transport service;
(*c*) to co-operate with the International Civil Aviation Organization and other international organizations.

I.A.T.A. is a voluntary non-exclusive, non-political, association of scheduled airlines. Any airline certificated to render scheduled service by a state which is itself eligible to join I.C.A.O. may become a member. As you will note from Appendix 7, there are today eighty international carriers who are active members of I.A.T.A. and nine associate members who are domestic carriers but have an interest in international interline traffic. Membership has grown steadily over the years and the present total of eight-nine will be increased in the future.

I.A.T.A. is democratic in nature. Every airline, large or small, has an equal vote in its proceedings; the size of members varies from the smallest, such as the intercity helicopter operator, to the large, globe-encircling systems of Pan American, B.O.A.C. and Air France. The source of authority is the Annual General Meeting and executive control is vested in an eighteen-member Executive Committee chosen with an eye to balanced representation of the various types of members and their

geographic distribution. Its Headquarters are in Montreal; and it has Branch Offices in New York, Paris and Singapore. It has a Clearing Office in London and a Technical Liaison Section there also. Its activities are organised, under the Executive Committee, by a series of standing committees:

The Finance Committee: The members of this Committee are drawn from the airlines and serve for a term of years. I.A.T.A. provides the Secretariat. The Committee deals with all aspects of the accounting and settlement between airlines for the business they do with each other or on each other's behalf; with the common problems of the airlines in regard to currency and exchange, taxation, insurance and statistics.

It has reconciled the financial and accounting systems developed independently in many parts of the world before airlines were linked by the intercontinental routes. It has developed working standard Manuals of Revenue Accounting Practices, cost reporting forms and forms for operating, profit and loss and surplus statements and similar documents. It carries on extensive studies of special insurance problems, taxation and similar matters. It works closely with traffic groups towards simplification of fares and rates.

A feature of this financial work is the I.A.T.A. Clearing House in London, through which the airlines settle accounts for interline revenue transactions. It enables them to collect and pay their world-wide debts simultaneously and by a single cash settlement and to do so either in dollars or convertible sterling, regardless of the number of national currencies involved. By offsetting accounts, the Clearing House eliminates the necessity for cash payment of almost 90 per cent of all monthly claims. It assures regular and punctual settlements of interline debts, eliminates much correspondence and other paper work, saves substantial foreign exchange expense and, moreover, affords protection in the event of currency devaluations. It is now running at about 1,000 million dollars a year.

The Legal Committee: Again the members are Airlines' Counsel or Legal Advisers with Secretariat provided by I.A.T.A. This Committee undertakes all legal matters having a bearing on international air transport, particularly international conventions on public and private air law, conflicts of law and arbitration. It is concerned with representing the airlines' views on the basic international conventions controlling the liability of air carriers and their legal relationships with their customers, with third parties on the ground, and with questions of rights in aircraft moving in international operations and the like.

Since the sale of a ticket or the issuance of a cargo waybill constitutes a contract between the airline and the customer, international airline documents must be legally valid under many different systems of law. The I.A.T.A. Legal Committee has thus been responsible for preparing the legal ground on which the whole structure of standardised interline agreement and documentation—tickets, baggage checks, air waybills and the like—has been erected.

The Technical Committee, whose members are the senior technical experts drawn from the airlines, has the most urgent and important task. Where safety is concerned there are no trade secrets. All technical activity is founded upon full exchange of information and experience of all the airlines. Out of this data the Committee tries to distil the common requirements, present and future, which guide the standardisation of their air activities and tries to determine the practical advice which is offered to Governments and above all tries to look about systematically and plan a safe future along the lines which developing technology promises. The Committee works closely with I.C.A.O. on the Technical Annexes already mentioned and with other bodies such as the International Telecommunication Union, the World Meteorological Organisation, International Standards Organisation and others.

The main technical event of each year is the Technical Conference which brings together some five hundred specialists in all branches of the technique

of air transport aeronautics drawn from the airlines themselves, from governments, air forces, manufacturers and research laboratories to discuss whole areas of operation. This process was started a decade ago when it became evident that all these specialities are inter-related and cannot function or breed in isolation. It has been of special value in helping airlines, suppliers and governments to prepare systematically for the introduction of turbine-powered aircraft and it has been brought to bear on such key areas as air traffic control, terminal area problems, flight training, approach and landing, and all navigational facilities. These Conferences do not make policy decisions. They indicate, with great authority, the operational requirement. Their aim is to enable everyone to see the problem whole, to comprehend the inter-relation of the parts, to establish priorities for development and to foster full exchange of information and experience, divorced from national or commercial interests.

Technological Revolution

It is with technical problems that I am mainly concerned here. I have indicated that the Technical Committee and the Technical Conference work with their eyes on the future. They have to. The future is rushing at them so quickly. Indeed our major concern is to digest the technological revolution brought about by the application of turbine power to civil air operations. The jet is the present preoccupation of the airlines and I must dwell for a moment on its implications. It is appropriate to say that this was a British invention and I am glad to have a photograph of Sir Frank Whittle on my wall. I am not a technical specialist and I have drawn on the knowledge and experience of my technical colleagues in I.A.T.A. for a good deal of what follows.

The Paradox of Complexity

Turbine power is already making a revolution in air transport; but the engine and the aircraft in which it is installed, and the aids and services they require, are evolutionary products. They flow from many developments which have mushroomed simultaneously in so many directions that it has become difficult to distinguish effect from cause. I would like to consider three fundamental parameters of aircraft growth: capacity, range and speed.

Immediately after the war, the airlines found themselves with an assortment of two-engined and four-engined aircraft, typified by the Douglas DC-3 and DC-4, designed to carry twenty-two and forty-four passengers respectively. Their still-air ranges were in the neighbourhood of 1,500 and 3,000 miles, and their maximum cruising speeds were 190 and 227 m.p.h. respectively. By comparison, the large four-engined intercontinental jet aircraft now coming into service have a capacity of up to 160 passengers; their still-air range has been raised to over 5,000 miles and they cruise at more than 550 m.p.h. So, at one and the same time, the speed of this new generation of aircraft has more than doubled, their range has substantially increased, and their passenger capacity has more than trebled.

But these gains have produced, or in some cases resulted from, secondary effects. Aircraft weights have increased fourfold, engine powers have multiplied by factor of six and, of course, not to be outdone, manufacturers' prices have risen eightfold over the same period. Equally important, the aircraft and its associated equipment have become vastly more complex. This trend towards complexity can be clearly illustrated by a closer look at the changes which have taken place since the war in the fields of airborne equipment and aircraft systems as well as in some associated ground handling requirements.

Systems within the Aircraft

Pressurisation: In 1946 pressurisation was relatively new in commercial aircraft and not widely available. The demands on pressurisation systems at that time

were not heavy, due to the smaller passenger loads and the fact that pressurised aircraft would not normally fly at altitudes above 25,000 feet. With the jets, operating ceilings have risen to 40,000 ft. (8 miles high) and passenger loads have increased; as a result, pressurisation systems have been forced in the direction of greater sophistication and complexity.

Electrics: In parallel with the modern American kitchen, greater use is being made of electricity by the aircraft designers today. But squeezed between the uncompromising limitations of weight on the one hand and higher voltages on the other, the design of electrical systems has inevitably become more complex. Today's large jet aircraft may have on board 26 miles of electrical wiring.

Controls: The higher cruising speeds of turbine-powered aircraft have presented the aircraft designer with new problems in controlling the aircraft. In some cases it has only been possible to solve these problems by resorting to such devices as power-operated controls—another retreat from the precept of simplicity.

Braking: Here the principles involved have remained substantially the same, but higher landing speeds of the new aircraft and their greater landing weights have imposed much heavier demands on the braking system, with the result that much ingenuity has been called into play to devise special systems to promote adequate dissipation of heat and to provide good non-skid characteristics.

Water Injection: With the advent of the jet engine, a requirement has been introduced for water injection in order to maintain power at high-temperature, high-altitude airports. And any new system, of course, automatically adds to the complication.

Noise Suppressors: While the turbo-jet engine has done away with the propeller at the front end of the engine, this gain has been off-set by the requirement for a noise suppressor at the other end. While the noise suppressor is relatively simple in construction, it is one more item which has to be carried around on the aircraft and which has to be maintained.

Warning Devices: Warning devices are nothing new on aircraft, but the trend towards complexity has promoted the proliferation of these devices in the cockpit to the extent where you may find as many as ninety of them in one of the new aircraft.

Hydraulics: Although the function of the hydraulic system has undergone little or no change in the new jets, here again heavier demands are being made on the system by the various controls, by the braking system, and so on. Once more it has meant greater complexity so that the weight of the hydraulic system might be kept within reasonable limits.

Ground Handling: Because of the high cost of the new aircraft and the demands of the industry, it is imperative that these aircraft spend as little of their time as possible on the ground. Maximum utilisation is vital. Consequently, a great deal of attention has been focused on the need to achieve rapid turn-round and transit times.

Paradoxically, this has sometimes meant that simplicity has had to be abandoned in favour of complexity—for instance, the classic method of refuelling an aircraft by pouring gasoline through an opening in the top of the tank has been virtually replaced by underwing pressurised refuelling. By this means, a vastly greater fuel load for long-range jet aircraft can be accepted by the aircraft in less time than it used to take to refuel a conventional long-range piston-engined aircraft. To put some figures to this statement, the modern jet aircraft with four underwing refuelling points can take on its full load of 23,000 gallons at a rate of 1,500 gallons per minute. Similarly, simplicity has been forfeited in a number of other ground-handling features in the interest of time-saving. Galleys have been made completely removable on some aircraft. Passengers steps have been incorporated in the doorways of others. The freight holds on certain aircraft have been designed to accommodate pre-loaded containers for baggage and freight.

Communications and Navigation Equipment: As in the case of the basic tool—the aircraft itself—the post-war years have brought forth a rapid development in the complexity of airborne radio equipment, and in the number of communications and navigation functions the aircraft is called upon to perform.

Let us look at the airborne radio equipment with which a typical civil air transport aircraft operating on international air routes had to be equipped in the immediate post-war years. Radio telegraphy was then the prevailing mode of communication for the exchange of traffic required to meet the needs of the airliners, as well as *en-route* air traffic services, and a general-purpose radio telegraphy transmitter and receiver were carried for this purpose. In addition, of course, such an aircraft was equipped with a simple very high frequency radio telephony transmitter and receiver to provide direct pilot-to-controller communications with airport approach and aerodrome control service. A basic airborne tool for navigation purposes was an airborne direction finder (radio compass) used in conjunction with ground-based non-directional beacons.

Due to developments of the aeronautical air navigation system, the modern transport aircraft is called upon to perform much more complex communications and navigation functions. Its communications equipment includes high frequency R.T. transmitters and receivers for general purpose *en-route* communications, multi-channel V.H.F. transmitters and receivers for direct pilot-to-controller communications with air traffic services, both *en-route* and in the terminal area and, of late, also for direct communication between the pilot and the ground organisation of his airlines. In fact, the speed of modern jet aircraft, the rate at which it has to contact various ground-based services, and the resulting cockpit workload, make automation the next logical technological step. In certain areas, e.g. the North Atlantic, some aircraft already carry the receiving equipment of a ground-to-air teletypewriter system used to pass meteorological and advisory information to aircraft in flight.

The increased numbers of aircraft now making demands upon the air space have dictated refinements in aircraft navigating capability. The basic system of non-directional radio beacons is still in use internationally and, therefore, airborne automatic direction finding equipment continues to be carried in the aircraft. Additionally, it must carry navigational equipment to receive signals emitted by V.H.F. omni-directional ranges (V.O.R.), instrument landing system (I.L.S.) and V.H.F. marker beacons. A large proportion of present-day aircraft are fitted with airborne weather radar, the functions of which are to indicate the optimum path through areas of storms and air turbulence, and with radio altimeters providing accurate indications of height above terrain. Congested terminal areas place additional demands on aircraft navigating ability and call for the carriage of distance measuring equipment and, of late, secondary radar airborne transponders to facilitate aircraft identification and provide positive returns from aircraft interrogated by ground-based radar. On some oceanic air routes, additional navigational equipment, such as LORAN, CONSOL, etc., is carried to facilitate navigation. More recently, there is a trend towards self-contained navigation in the aircraft, already evidenced by Doppler Radar Navigation Systems and Navigation Computers fitted in the generation of jet aircraft now coming into service. I think it is appropriate to remind you that radar, like the jet, was a British invention and I am glad to have a photograph of Sir Robert Watson Watt on my wall, next to Whittle's.

A typical modern air transport aircraft therefore carries a formidable array of airborne equipment which includes two H.F. radiotelephony transmitters and receivers, two V.H.F. radiotelephony transmitters and receivers, two navigational receivers for the reception of V.O.R. and I.L.S. signals, one V.H.F. marker receiver, two airborne automatic direction-finding receivers, and one airborne weather radar transmitter and receiver. Additionally, the very latest aircraft are equipped

with two complete Doppler Radar Systems, and in certain areas, with standard LORAN.

Instrumentation and Automatic Control: Many of the devices just mentioned serve the purpose of providing a reliable source of more accurate navigational information than was formerly available. Considerable complexity has been built into these devices in order that they may present their information in the most useful form, that is on direct-reading instruments which require little or no further calculation by the pilot. Thus, complex navigational equipment has borne the very desirable fruit of simple navigation.

The old basic flight instrument panel contained six instruments which showed airspeed, altitude, heading, vertical speed, roll and pitch, and rate of turn and slip; some of these were activated gyroscopically and others by means of air pressure. The gyroscopic direction indicator had to be set periodically by reference to an ordinary magnetic compass, though a number of aircraft were equipped with the flux-gate, which is a gyro-stabilised magnetic compass. The typical aircraft panel would also contain at least one radio compass, for finding the direction of transmitting stations, and a deviation indicator for the S.C.S.51 (the precursor of the modern I.L.S.).

In the large modern jet, the number of flight instruments has not increased. The only fundamentally new instrument is the machmeter, which indicates the ratio between the aircraft's speed and the local speed of sound and which is used in setting up cruising speeds, and in controlling speed generally in the higher ranges.

However, one very important new principle has emerged: that of command instrumentation. Formerly the pilot was confronted with a mass of raw information which he had first to digest before deciding upon the correct action. Now, the raw information is predigested by an electronic device which computes the correct action and presents the information in a manner which tells the pilot directly what control manipulations he should make; in fact, he reads 'a command' from the dial. Thus, the task of flying large aircraft on instruments, which was becoming undesirably burdensome to the pilot, has been simplified in one aspect, again, however, at some cost in complexity.

A great deal of work has been done in the field of instrument design, with the result that although one given dial may now provide several more items of information than formerly, it does so more clearly.

A moment ago, I mentioned an electronic device which predigests information for the pilot. This, often made up of several subsidiary devices, is generally called 'the coupler', and does a double duty in that it also controls the automatic pilot. The early auto-pilots were devices which enabled aircraft to be flown substantially straight and level over a short period of time without the pilots touching the controls. They controlled an aircraft's attitude and heading by reference to gyroscopes, but their ability to control aircraft in manœuvres was extremely limited.

The modern auto-pilot with its coupler has so wide a scope that it has now commonly to be referred to as a 'flight control system'. Not only can it control the aircraft straight and level, holding to an altitude, but it can perform a wide range of manœuvres, including the approach to land, acting automatically on signals coming from the navigational aid receivers.

Aircrew

I have mentioned some of the aspects of increasing complexity in aircraft themselves, in their airborne equipment, and in their need for equipment on the ground: may I now say a word about the pilots who fly these aircraft.

Earlier in this paper, I mentioned the change-over from wireless telegraphy to direct-speech radio telephony; and the introduction of direct-reading navigation and command-type instruments. These changes have helped to make the pilot's

job easier and have eliminated the need for a radio-operator and, in most cases, a navigator. Nowadays, the pilot must exercise manual skill for a smaller proportion of the total flight time: he 'flies' less and supervises more. Except for take-off and landing, he is now the manager of an increasingly automatic aircraft.

However, the greatly increased complexity of aircraft and equipment means that the pilot needs more detailed knowledge, both for routine operation and in emergencies. He must, more than ever, be consummately trained. In an airline, routine training and checking of pilots is a daily activity. A special need for training arises when a new, large aircraft is introduced. When this happens, the pilot's increased need for knowledge can largely be met by ground training, and some very satisfactory techniques have been evolved, notably the use of dynamic models of aircraft systems. In learning manual skills, the amount of airborne training on a revenue-earning aircraft must be cut to whatever minimum is consistent with the need to enable the pilot to take-off and land safely on the new type, and to avoid or recognise dangerous conditions of flight. All other training in manual skills can be done more economically in the realistic simulators now available, despite the fact that such simulators are themselves costly and so complex that they require both special instructors and mechanics. It is on these simulators that pilots can perfect the drills and automatic actions which must be carried out when an emergency occurs. They cost a million dollars.

Airline Organisation

As an airline's routes and fleet expand, its organisation necessarily expands, too, and becomes more complex. But additional complexity is also introduced by larger aircraft.

This increasing complexity of aircraft means that not only are larger armies of more specialised people needed to operate them, but that further armies of the most sagacious specialists are needed to study the characteristics of aircraft in the planning stage, to compare the relative merits of competing designs from the point of view of integration with the company's present and future operations and existing fleet, to order the right aircraft at the right time and in the right number, and to maintain close liaison with the manufacturer throughout the aircraft's development. To give an idea of the increasing scientific sophistication and need for specialisation which this involves, I have borrowed Appendix 8 from the recent Wilbur Wright Memorial Lecture by Mr. Charles J. McCarthy, Head of Chance Vought Aircraft, Inc.

The cost of aircraft, engines and spare parts is such that the task to be done must involve as few as possible of all these specialists, which means that as few as possible must be idle at any one time. This means careful and intricate planning of aircraft routing and maintenance, leading to a specialised planning staff in both the operations and the engineering field, whose functions cover not only existing aircraft but also future aircraft, often many years in advance.

The detailed planning of maintenance operations and of spares' stocking and positioning, often for several aircraft types and at several bases, has led to the use of the most advanced statistical techniques and to the use of computers, with their associated specialists and technicians. However, the losses which can result from over-stocking, or from delay due to under-stocking, or from poor maintenance scheduling, are economically reduced by such techniques.

Jets and Productivity

All that I have said so far has dealt with the technical complexity of aircraft and the resulting complexity of airline operation. You may well be inclined to ask if it is really worth while.

The most useful result of the revolution which has led us to these large and

complex jet aircraft is their markedly increased productivity. 'Productivity', as applied to an aircraft, refers to the rate at which it can do transport work, and is calculated by taking average speed from engine start to arrival, and multiplying it by payload. A recent economic survey by I.C.A.O. indicates that, assuming average operational conditions, the productivity of the Boeing 707-420, in ton-miles per hour, is more than 8½ times as great as that of the D.C.4.

Of course, productivity is not the whole story. This, and other such advantages as the notable increase in range over the years, are not necessarily desirable in a commercial sense, unless the cost of doing the work can be reduced.

Direct-operating costs are the normal yardstick by which the commercial desirability of an aircraft is assessed. These costs, which include the depreciation of an aircraft over a number of years, are calculated by different formulae, according to the economic conditions of the country, the type of operation, or the whim of the economist. Though the calculations for large jet aircraft vary in degree, they all show one trend: the direct operating costs per ton-mile are significantly reduced. This is why the airlines have turned to the jet. The operator produces and sells a public service, the passenger seat-mile and the cargo ton-mile. The only way to keep ahead of the rising costs of materials and services is to improve productivity and expand the market. How well this has worked is testified by the fact that more passengers are flying the Atlantic today in Superconstellations than flew the route in DC-4s when the I.A.T.A. Traffic Conferences began, at fares which have been reduced by 30 per cent in shillings and pence. In terms of the working time required to earn the price of the ticket in manufacturing industries in the U.S. and the U.K., the reduction has been 60 per cent.

Thanks to the descending curve of fares and the rising standards of living in many countries, these postwar years have thus given the airlines their first taste of the mass market and they are convinced that this is where their future lies. The last generation of piston-engined aircraft represented the absolute limit of the productivity which could be squeezed from this form of motive power. The industry cannot lower its fares by cutting a non-existent operating profit. The actual operating loss for 1958 was 160 million dollars as shown in Appendix 5. The continuation of expanding air transport therefore requires that the airlines avail themselves of the greater productivity of the jet. Since the price of the jet and its operating cost per mile are high, the airlines have been criticised for paying an excessive amount for speed. The fact is that the speed is virtually incidental: the jets carry more seats and what the airlines are buying is the lower cost per seat-mile. This is the present position of the industry. The technology of air transport dictates that in order to keep one jump ahead of our own costs, airlines must use more efficient and more economical aircraft. This means aircraft of much greater productive capacity, which must be filled with a larger payload. To get this increased payload, charges to the consumer must be reduced. This is a circle, but not necessarily a vicious one, for the potential demand for airline service is so vast that present carryings are infinitesimal in comparison with what we hope for when we can cater for the millions who want to travel for pleasure.

This brings us full circle to the machinery for creating suitable fares and rates and this is the province of the Traffic Conferences.

Traffic Conferences

To cope with this problem and to weld its member airlines into a single commercial network, I.A.T.A. has produced a series of interline agreements (to which many non-I.A.T.A. and domestic carriers are parties as well) covering all phases of passenger, baggage and cargo handling, reservations codes and the like. The standard I.A.T.A. ticket, baggage check and air waybill have become, in effect, magic carpets to anywhere, for passenger and goods as well. The I.A.T.A. Restricted

Articles Code, of 2,000 items, represents the first world-wide agreement on standard handling and treatment of special cargoes, so that these can move freely between the routes of its parties. Through other I.A.T.A. agreements, the airlines have adopted standard codes of relations with their passenger and cargo agents and consolidators, which assure the agents of fair and non-discriminatory treatment. Special boards and committees screen all agencies, examine their qualifications to serve both public and airlines and, in effect, to act on behalf of the airlines in choosing their middlemen. The application of these many decisions is made through Traffic Conference Resolutions all of which are subject to the approval of governments before they can become effective. Each government reserves control over its own airspace and the right to determine what its air services may charge the public. International fares and rates must therefore be fixed by international agreements in which virtually every country has some direct or indirect concern. Most nations have agreed that the complicated work of negotiating detailed agreements on rates and fares should be delegated in the first instance to the I.A.T.A. Conferences. For administrative purposes, there are three I.A.T.A. Traffic Conferences—No. 1 for the Western Hemisphere, Greenland and the Hawaiian Islands; No. 2 for Europe, Africa and the Middle East, including Iran; and No. 3 for Asia, Australasia and the Islands of the Pacific. All three meet at the same place and time to prepare for the traffic year. These sessions are prefaced by preparation and study, not only by continuing Traffic Working groups, but also by Cost Committees which forecast the costs of operation in the light of equipment and changing circumstances.

In the Conferences, every member holds a single vote. All agreements must be reached by unanimity: thus, every airline, regardless of size, also holds an effective veto. The Conferences may accept advice from other parts of I.A.T.A., but within the terms of reference they are responsible only to governments and thus, to the public, for what they do. The resulting structure of I.A.T.A. Traffic Conference agreement—now comprising some 500 resolutions, including 30,000 agreed rates and fares and the rules for constructing thousands of others—covers every phase of commercial activity. These are the legislation of international air commerce. Like all effective legislation the I.A.T.A. resolutions are watched by an Enforcement Section which, under the Director-General, assures that members respect the obligations which they have voluntarily assumed. Despite the complexity of world airline operations, the pattern of agreed rates and fares has been extended to every area of the world. It has been flexible enough to keep pace with the rapid expansion of routes and traffic since 1946, and to provide for the blue ribbon luxury services of the North Atlantic and the regional feeder services of less developed areas. It has also been strong enough to withstand many drastic fluctuations in exchange rates as well as great fluctuations in seasonal traffic.

The fact that less than 3 per cent of the Conference resolutions have ever been disapproved, even in part, by governments, is an indication of their close attention to the public interest.

Finally, this pattern of agreement has been realised without sacrifice of the individuality of any of the airlines which are a part of it, and without interfering with the normal and beneficial workings of competition. While the Conferences have fulfilled one obligation to governments by maintaining their rates at an economic level which will not touch off cut-throat rate wars and create a drain upon public treasuries, they have also been able progressively to reduce the price of air transport to the public.

The Conferences will be held in Honolulu this year. There will be three weeks of hard discussions which will be of interest to governments, to the public and to the airlines themselves. What will they face and what circumstances will govern their discussions and resolutions? The jets will intensify everything. Not only is it a very productive unit of transport, but it will fly over half a dozen countries in as

many hours; it will loosen still further frontier formalities; it will break down isolation; it will give a further impetus to economy travel; it will demand bigger markets; it will cater for a world which shows a rising standard of living and an increasing urge to travel; it will stimulate the building of hotels and motels in all tourist countries; it will intensify the present volume of advertising, for travel is only one attraction to people with disposable dollars. The volume of travel we want must compete with television sets, new cars, washing machines and swimming pools and we must be sure to divert the dollars into the travel market. We must, in short, get passage fares and cargo rates down still further. The fares are like a dam on a large river. Lower the height of the dam, even a little, and a very large volume of water will flow over. Raise it, and the overflow stops. It is the task of the Conferences to recognise these facts of the life about us and come up with fares and rates which governments can approve and which the public will find too attractive to ignore. The potential is there. In 1957, Americans spent $593,000,000 on air transport of all types. This is an increase of 460 per cent over what was spent in 1946, but it is still only 0.2 per cent of the total spent on goods and services in the country in 1957. U.S. economists have been studying what they call 'income sensitivity coefficients'. This study indicates that for every 1 per cent increase in the disposable income of the U.S. consumer, he will spend 3 per cent more on air transport than he did before. It was the highest figure in the table. If this sensitivity to air transport can be combined with lower fares, the prospect looks bright. And I say bright, even though the airlines last year handled a record turnover of over four thousand million dollars, did an inordinate amount of work and finished the year with an operating loss of 160 million dollars. And this at a time when they are all finding new capital, of an unprecedented order of magnitude, for their new jet fleets. Capital investment in the airlines over the last ten years shows an increase of 150 per cent on the average. Having done this, will they be able to find vastly greater amounts in the next few years? I am confident that the answer is affirmative; and I am not being a Micawber. Our position is that of any industry which is in the process of retooling at the same time as it is carrying on its normal commercial activity. But we are also an industry with a high sensitivity to temporary external vicissitudes. Even if there is a depression, people go on drinking water and eating food; but a slight recession will check pleasure air travel very quickly. Happily, however, a phase of prosperity brings high rewards. We are rather like a child's temperature, soon up, soon down.

I have touched briefly upon the technological advances of the last few years as applied to the aeroplane of tomorrow and its path through the air. I have said nothing about modern airports and methods of ground handling, the problems of labour and training, the insurance and liability problems which are our constant concern. There is no space to deal with these things but I must make one general point which brings them all in and which is a comprehensive headache. We have to recognise that air transport is a 'system' and we must look at new technical developments in the light of its place in the whole chain of facilities and arrangements which are required to get a payload from point to point with optimum speed, safety, and economy. We can cope with the jets; and the terminal facilities, the airports, the runways and the navigation aids they require will come along in phase. But if manufacturers, inspired and driven by the dedicated designers in their project offices, suddenly throw at us a supersonic aircraft which can do 2,000 miles an hour before the rest of the system is in phase to accept it, we shall run into difficulty. We must advance like an army in good order: the flanks and the centre, the air cover and the logistics must maintain effective contact, and the technical side must not hurry us beyond what the rest of the system will bear.

Another general comment I must make is that, after fourteen years' experience I still stand amazed by the fact that eighty international carriers, representing

fifty countries, with varying equipment, with different lengths of route, differing classes of business, different outlooks and prejudices, differing languages, currency, religion and standards of living, can get down to a discussion of world-wide rates and fares, a baggage allowance, or agency matters or interline matters and reach unanimous decisions. This is demanded by the operational logic of a world transport system and because every government has the right to approve, disapprove and amend the rates charged their people by the airlines which serve them. In order to make the system work, all the operators give up a little of their autonomy, or their managerial function, or shall I say their sovereignty, in order to reach an agreement, one which none may like but which each can live with. We have thousands of fare and rate agreements and other resolutions and business arrangements of the greatest complexity; yet day in, day out, one airline ticket or one airway bill will take a man or a package thousands of miles across the routes of many carriers.

This co-operation, this yielding up of autonomy in the interests of the whole, will be intensified by the equipment we are now buying. I am sometimes tempted to think that on the higher level of international politics, we—and our children and grandchildren—would be in a happier position if nations voluntarily yielded up a little of their national sovereignty and subjected themselves to the observance of a rule of law. That is not a theme for this paper but I know many pioneers in the international air business turn their thoughts in this direction after a generation's experience of the co-operation which I.A.T.A. produces amongst the airlines great and small.

I will not go so far as to say that I.A.T.A. represents a small successful working model of a democratic process on a world-wide basis although in my opinion it comes close to that. But I do believe that the statement in Chapter 1 of the Chicago Convention that 'every State has complete and exclusive sovereignty over the air space above its territory' is a doctrine which must give concern to the Almighty. National sovereignty undiluted by the rule of law becomes ever more dangerous.

Finally, I would say that what keeps the job sweet for me is the increasing knowledge and friendship on the part of all peoples which it makes possible. Our job is to consolidate the enormous promise of this development and ensure that the jets will carry increasing numbers of human beings in safety with the object of creating better standards of living and a higher degree of friendship, mutual confidence and international understanding at the level of the people. If the aim of science is to do honour to the human spirit, we have in the aeroplane, that complex of technological excellences, one of the finest instruments ever made by man for his own well-being and happiness.

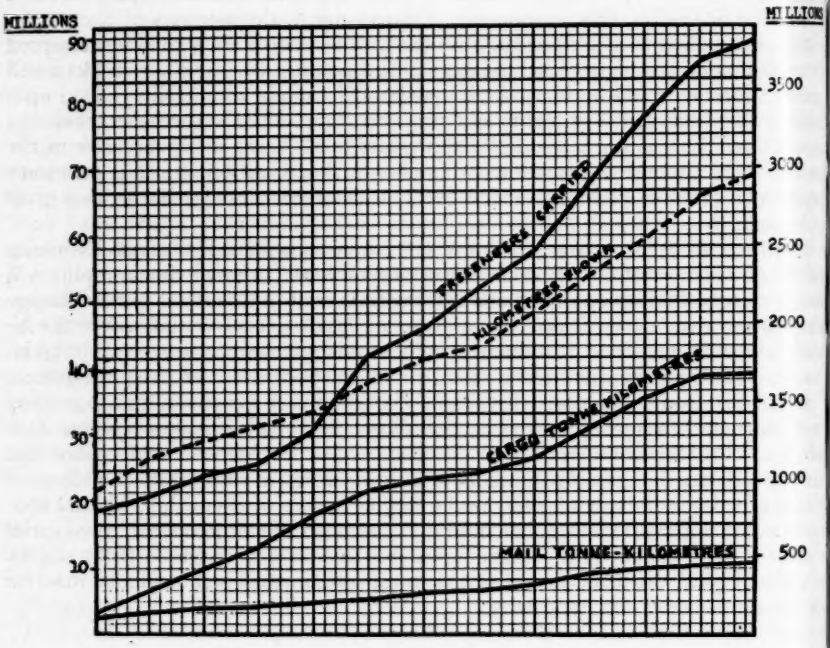
Appendix 1

GROWTH OF CIVIL AVIATION

Total Scheduled Services[1], 1946–58

Passengers carried

Kilometres flown
Cargo tonne-km.
Mail tonne-km.



Source: International Civil Aviation Organisation Data.

[1] International and Domestic Traffic. Excludes U.S.S.R. and People's Republic of China.

Appendix 2

GROWTH OF CIVIL AVIATION

Total Scheduled Services,[1] 1946–58

(in millions)

Year	Kilometres Flown	Passengers Carried	Passenger Kilometres	Cargo tonne-Kilometres	Mail tonne-Kilometres
1946	940	18	16,000	120	100
1947	1,140	21	19,000	270	130
1948	1,270	24	21,000	420	170
1949	1,350	27	24,000	570	190
1950	1,440	31	28,000	770	200
1951	1,620	42	35,000	930	240
1952	1,770	46	40,000	1,000	260
1953	1,920	52	47,000	1,050	280
1954	2,070	58	53,000	1,130	330
1955	2,300	68	62,000	1,330	380
1956	2,540	77	71,000	1,520	410
1957	2,820	86	82,000	1,660	440
1958	2,970	89	86,000	1,670	470

Source: International Civil Aviation Organisation.

[1] International and Domestic Traffic. Excludes U.S.S.R. and People's Republic of China.

Appendix 3

I.A.T.A. MEMBERSHIP, NUMBER OF EMPLOYEES AND OPERATING FLEET OF I.A.T.A. MEMBER AIRLINES

1949–58

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Membership[1]	63	62	62	67	70	71	73	76	81	87
Number of Employees ('000)	176	181	202	225	242	253	274	304	336	366[2]
Operating fleet	2,008	1,992	1,982	2,380	2,500	2,525	2,580	2,790	3,106	3,400[2]
Percentage of 4-engined aircraft	39%	38%	41%	37%	41%	43%	46%	47%	52%	54%
Average seats per aircraft	31·8	34·7	37·0	39·7	42·7	46·8	48·3	49·5	51·3	53·1[2]
Maximum seating capacity	100	100	106	106	107	107	107	107	133	150
Average speed (m.p.h.) (Block Speed)	n.a.	n.a.	187	191	198	204	209	212	215	220[2]
Maximum cruising aircraft (m.p.h.)	340	340	340	490	490	365	365	365	397	591

Source: I.A.T.A., with the exception of items 'Maximum Seating Capacity' and 'Maximum Cruising Speed of Fastest Aircraft', which were obtained from *Jane's All The World's Aircraft.*

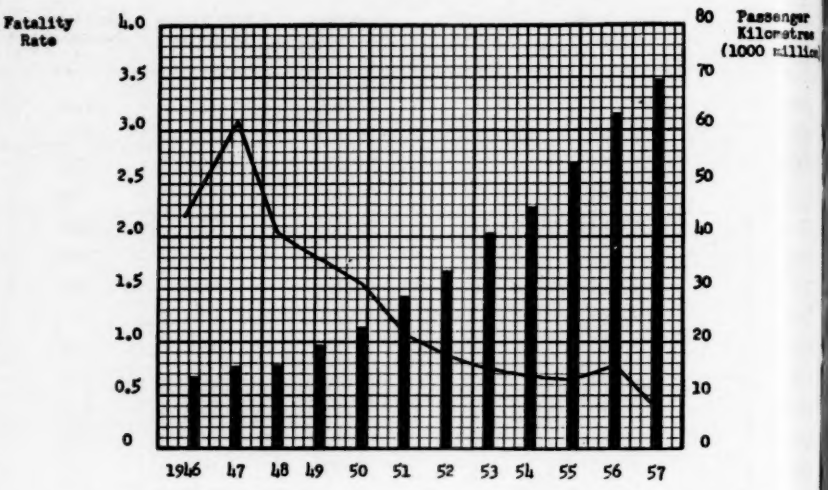
[1] I.A.T.A. membership to which figures relate.

[2] Provisional figure for 1958.

APPENDIX 4

COMPARISON I.A.T.A. MEMBER AIRLINES

Traffic Growth and Safety Record Trend, 1946–1957



——— FATALITY RATE—Passenger Fatalities per 100 million Passenger Kilometres.
▬▬ TRAFFIC—Revenue Passenger Kilometres.

APPENDIX 5

WORLD'S SCHEDULED AIRLINES[1]

Operating Revenues and Expenses, 1947–58

	1947	1948	1949	1950	1951	1952
Operating Revenues (US $ millions) . . .	1,050	1,348	1,397	1,543	1,804	2,050
Operating Expenses (US $ millions) . . .	1,170	1,397	1,406	1,502	1,780	2,063
Operating Profit or Loss (US $ millions) . .	−120	−49	−9	+41	+24	−13
Per cent. .	−10·3	−3·5	−0·6	+2·7	+1·3	−0·6

	1953	1954	1955	1956	1957	1958[2]
Operating Revenues (US $ millions) . . .	2,314	2,560	3,025	3,510	3,971	4,200
Operating Expenses (US $ millions) . . .	2,317	2,528	2,947	3,426	4,012	4,360
Operating Profit or Loss (US $ millions) . .	−3	+32	+78	+84	−41	−160
Per cent. .	−0·1	+1·3	+2·6	+2·5	−1·0	−3·7

Source: International Civil Aviation Organisation.

[1] Excludes U.S.S.R. and People's Republic of China.
[2] 1958 Estimated.

APPENDIX 6

ANNEXES TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

1. Personal Licensing	Licensing of operating and maintenance personnel.
2. Rules of the Air	Rules relating to visual and instrument flight.
3. Meteorology	Codes, meteorological communications and meteorological services.
4. Aeronautical Charts	Standardisation of charts for use in international aviation.
5. Dimensional Units to be used in Air–Ground Communications	Reduction in the variety of dimensional systems.
6. Operation of Aircraft—International Air transport	Specifications which will ensure in similar operations throughout the world a level of safety above a prescribed minimum.
7. Aircraft Nationality and Registration Marks	Requirements for registration and identification of aircraft.
8. Airworthiness of Aircraft	Certification and inspection of aircraft according to uniform procedures.
9. Facilitation	(see page 31)[1]
10. Aeronautical Telecommunications	Standardisation of communications systems and radio air navigation aids.
11. Air Traffic Services	Establishment and operation of air traffic control, flight information and alerting services.
12. Search and Rescue	Organisation of facilities and services necessary for search and rescue.
13. Aircraft Accident Inquiry	Uniformity in the notification, investigation of and reporting on aircraft accidents.
14. Aerodromes	Characteristics and equipment for aerodromes used in international air navigation.
15. Aeronautical Information Service	Uniformity in methods of collection and dissemination of aeronautical information.

[1] This Annex is the responsibility of the Air Transport Committee, not of the Air Navigation Commission.

APPENDIX 7

I.A.T.A. MEMBERSHIP AS AT JUNE 15, 1959

Active Members

*Aer Lingus Teoranta (Dublin)
*Aerlinte Eireann (Dublin)
Aerolineas Argentinas (Buenos Aires)
Aeronaves de Mexico S.A. (Mexico City)
Aero O/Y (Helsinki)
*Aerovias Nacionales de Colombia (AVIANCA) (Bogota)
*Air Algerie (Algiers)
*Air Ceylon Limited (Colombo)
*Air France (Paris)
*Air India International (Bombay)
Air Liban (Beirut)
*Air Vietnam (Saigon)
*Airwork Limited (London)
*Alitalia-Linee Aeree Italiane (Rome)
*American Airlines Inc. (New York)
*Austrian Airlines (Vienna)
*Aviacion y Comercio S.A. (AVIACO) (Madrid)
†Braniff International Airways (Dallas)
*British European Airways (London)
*British Overseas Airways Corporation (London)
*Canadian Pacific Air Lines (Vancouver)
*Central African Airways Corporation (Salisbury, Southern Rhodesia)
*Ceskoslovenske Aerolinie N.P. (Prague)
Civil Air Transport Co. Ltd. (Taipei)
†Compania Cubana de Aviacion (Havana)
*Compagnie de Transports Aériens Intercontinentaux (TAI) (Paris)
*Cyprus Airways Limited (Nicosia)
†Delta Air Lines Inc. (Atlanta)
*Deutsch Lufthansa (Cologne)
Divisao de Exploracao dos Transportes Aereos 'DETA' (Lourenço Marques)
Divisae de Exploracao dos Transportes Aereos 'DTA' (Luanda)
*Eagle Airways of Britain (London)
East African Airways Corp. (Nairobi)
†Eastern Air Lines Inc. (New York)
El Al Israel Airlines (Tel Aviv)
*Empresa de Viacao Aerea Rio Grandense (VARIG) (Porto Alegre)
*Ethiopian Air Lines (Addis Ababa)
*Flugfelag Islands H. F. (Reykjavik)
*Garuda Indonesian Airways N. V. (Djakarta)
*Guest Aerovias Mexico S.A. (Mexico City)
*Hunting-Clan Air Transport Ltd. (London)
*IBERIA, Lineas Aereas de España (Madrid)
*Indian Airlines Corporation (New Delhi)
Iranian Airways (Tehran)
*Iraqi Airways (Baghdad)
*Japan Air Lines Co. Ltd. (Tokyo)
*Jugoslovenski Aerotransport (JAT) (Belgrade)
*KLM Royal Dutch Airlines (The Hague)
Linea Aerea Nacional (LANCHILE) (Santiago, Chile)
*Linea Aeropostal Venezolana (Caracas)
*Malayan Airways Ltd. (Singapore)
*Middle East Airlines Co. S.A. (Bierut)
Misrair S.A.E. (Cairo)
†National Airlines Inc. (Miami)
*Northwest Airlines Inc. (St. Paul)
†National Airlines Inc. (Miami)
*Olympic Airways S.A. (Athens)
*Parkistan International Airlines Corp. (Karachi)
*Panair do Brasil S.A. (Rio de Janeiro)
*Pan American Grace Airways Inc. (New York)
*Pan American World Airways Inc. (New York)
*Phillipine Air Lines Inc. (Manila)
Polish Airlines 'LOT' (Warsaw)
*Quantas Empire Airways Ltd. (Sydney)
Real Aerovias Nacional (São Paulo)
*Scandinavian Airlines System (Stockholm)
*Seaboard & Western Airlines (New York)
Servicos Aereos Cruziero do Sul S.A. (Rio de Janeiro)
*Skyways Limited (London)
*Société Anonyme Belge d'Exploitation de la Navigation Aérienne (SABENA) (Brussels)
*South African Airways (Johannesburg)
Sudan Airways (Khartoum)
*Swiss Air Transport Co. Ltd. (Zurich)
*Tasman Empire Airways Ltd. (Auckland)
*Trans Canada Air Lines (Montreal)
Transportes Aereos Portugueses (TAP) (Lisbon)
*Trans World Airlines Inc. (New York)
*Turk Hava Yollari (Ankara)
*Union Aéromaritime de Transport (UAT) (Paris)
†United Air Lines (Chicago)
*WAAC (Nigeria) Limited (Lagos)

Associate Members

*Australian National Airways (Melbourne)
Chicago Helicopter Airways Inc. (Chicago)
Flying Tiger Line Inc. (Burbank)
Hawaiian Airlines (Honolulu)
†New York Airways Inc. (New York)
*New Zealand National Airways Corp. (Wellington)
*Quebecair Inc. (Rimouski)
*Trans Australia Airlines (Melbourne)
Trans Caribbean Airways (New York)

*Members of I.A.T.A. Clearing House

†Clears via Airlines Clearing House

Appendix 8

STATE OF ARTS REQUIRED BY AIRCRAFT INDUSTRY

Circa	1910	1935	1955	1965
Type of Vehicles	Small Flying Aircraft	Subsonic Aircraft	Supersonic Aircraft and Missiles	Manned Satellites, Space-ships
New Technical Areas	Mechanical Arts	Aerodynamics Structure Materials	Thermodynamics Electronics Nuclear Physics Computing Machines Aero Medicine	Rarified Gas Dynamics Solar Energy Magnetohydrodynamics Astrophysics Radiation Physics Particle Physics Space Navigation
Highest Level of Education Required	High School or some College	B. of Science or Engineering	Ph.D. in Science, Engineering, Mathematics	Ph.D. and Post Ph.D. Fellowship
Organisations and Facilities	Garage or Shop	Engineering Dept. and Factory	Engineering Dept. Engineering Laboratory Tooling Dept. Factory	Engineering Dept. Research and Mathematics Groups Research Laboratories Factory and Tooling

(Taken from 47th Wilbur Wright Memorial Lecture given by Charles McCarthy, Chairman, Chance Vought Aircraft, Inc.).

THE ADVANCEMENT OF SCIENCE

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE was founded in York in 1831. The popularising of science was one of its main original objectives: it still is but the audience is now different. Then it was a small educated minority, now—directly or indirectly—it is the whole nation. While, therefore, the Association's Annual Meetings still provide an unique opportunity for scientists, as well as for non-scientists, to meet together, the Association is also now engaged in a major effort to present science to the public at large throughout the year.

The Council of the Association have decided, therefore, to make a number of changes in their journal, THE ADVANCEMENT OF SCIENCE, as part of this expanded campaign of new activities.

From May, 1960, THE ADVANCEMENT OF SCIENCE—at present a quarterly magazine—will be published six times a year in an entirely new format.

THE ADVANCEMENT OF SCIENCE will contain articles contributed by eminent scientists at the Meetings of the Association, especially invited articles, notes and comments on matters of interest in the whole field of science, news of the Association's own activities and reviews of selected scientific books and films.

The range of contents of future issues will attempt, as do the Association's great Annual Meetings, to reflect and report progress in the whole field of scientific endeavour.

ASSEMBLY OF CORRESPONDING SOCIETIES[1] YORK, 1959

On the morning of Thursday, September 3, members were cordially welcomed by the President of the Section (The Countess of Albemarle, D.B.E.), in the Castle Museum, York. Mr. Patrick Moore, in a lecture on 'Problems of the moon' (which followed), discussed such matters as the supposed methods by which craters have been formed, the nature of the moon's surface, the lack of atmosphere and of life, and the possibility of being able to photograph the moon's dark side from rocket vehicles.

At the annual Conference of Delegates which occupied the second part of the morning, Mr. R. A. Stevens, Assistant Secretary of the Association, presented a report on the formation of area committees throughout Great Britain and Northern Ireland. The function of these committees is to spread scientific knowledge to the younger generation, whereby those with the inclination may be led to consider a branch of science as a career. Delegates were reminded of the part local scientific societies could play in furthering the project. A considerable discussion ensued and several suggestions were put forward. In the remaining time delegates discussed domestic problems.

In the afternoon The Countess of Albemarle, D.B.E., delivered a stimulating Presidential Address, under the title of 'Living with science', which is published in full in this issue of *The Advancement of Science* (see p. 205).

The first paper on the morning of Friday, September 4, dealt with 'Air pollution and its effects on man', and was presented by Dr. P. J. Lawther, of the Medical Research Council Group for Research on Atmospheric Pollution. Dr. Lawther spoke of the complexity of his subject and the obscure clinical effects which were so difficult to study. Recent work permits classification—'smog' being pollution in its worst form. Concern with the drama of 'smog' should not deflect attention from day-to-day pollution in urban areas, certain forms of which deserve special study. Evidence is accumulating which points to air pollution as an important factor in bronchial complaints and to a belief that the general squalor produced by foul air is responsible for much mental misery and depression—and its organic consequences.

Mr. P. Ritchie Calder, C.B.E., later addressed the meeting on 'The use and misuse of science', stressing the fact that scientific discovery can be beneficial, as well as potentially destructive and a source of fear. Instances in each case were discussed as were the responsibilities of scientists as citizens.

The afternoon was taken up with two papers of exceptional interest each dealing with ways of improving the character and behaviour of difficult young people by the performance of worth-while tasks under appropriate leadership. First, Brigadier E. F. E. Armstrong spoke of 'The Council of Nature's scheme for the formation of conservation corps, its scope and its problems'. The tasks set were usually for manual workers between the ages of 16 and 23; and occupied a period of three weeks. The working of this scheme had shown 'that there is a strong desire among young men and women to be afforded an opportunity to take part in work for the preservation of plant and animal life of the countryside'. There followed a paper by Mrs. Edrie Green. She collects boys from large towns adjacent to the Peak District

[1] A report of the proceedings of the Assembly of Corresponding Societies (Section X) at the York Meeting of the British Association, September 2 to 9, 1959.

and forms them into 'The Kyndwr Scwd mountain training group'; they have plenty of enthusiasm for outdoor life but in the past have had no guidance, so Mrs. Green has devised a scheme for teaching the boys at least the elements of citizenship through organised activity, such as mountaineering and camping. Both schemes show considerable promise and are to be commended.

Dr. W. E. Swinton was unfortunately unable to give his talk on 'New horizons in science' on Monday, September 7, because of pressure of official business, but Mr. P. Ritchie Calder volunteered to speak in his place using the same title. To him cordial thanks were extended for a generous action, and a stimulating address.

A descriptive demonstration concerning 'Wool craftsmanship in York' was then presented by Mr. Robert Patterson, Curator of York Castle Museum. The Museum houses a fine collection of apparatus and implements with which the wool worker of old equipped himself to exercise high skill in the production of the top-grade cloth for which the City and County of York have long been renowned. What would have been—under ordinary circumstances—but inert exhibits, came to life in Mr. Patterson's hands to provide a fascinating story of past endeavour.

The final morning—Tuesday, September 8—was, as has been the custom since 1955, given over to 'Science by the upper form', when boys and girls of formative age are encouraged to speak on some scientific project on which they have been engaged. The first speaker was Mr. M. L. M. Wright (Ampleforth College, York) who, under the title of 'Physiography and scenery of the Isle of Eigg', explained work done by himself and associates in an isolated area only some 12 square miles in extent, off the west coast of Scotland. He dealt with the isle's geological features, the varying salt content of the soil, and with the plant life found and collected. Then Mr. A. N. P. Butland and Mr. P. A. Crossley (St. Peter's School, York) took up the running with 'Some scientific aspects of the River Ouse', the former confining himself to the work of the chemist in connexion with water supply, while the latter dealt with 'foaming' in rivers and canals, a natural phenomenon accentuated today by the use of detergents. Mr. Shaun Firth (Bootham School, York) followed with a talk on 'Sedges of Askham Bog'. As no systematic study of these plants on the Bog had ever been undertaken, Mr. Firth, along with school friends, decided to remedy this omission; his talk took the form of a progress report. Much good work has already been done and will be followed up. The Bar Convent Grammar School, York, was well represented by Miss Nancy Proctor who gave an account of Roman York, based on her own experience when helping to carry out excavation work in the City—another school team effort. Finally, Miss Eileen Burton as speaker, and Miss Joanne Littlefair as illustrator, dealt with 'The seasonal rhythm and behaviour of the birds of Bempton Cliffs'. Both are scholars of the High School for Girls, Bridlington, Yorks, and have been working along with school colleagues. Members made weekly visits to the Cliffs, produced counts of species present and, in particular, dealt with six nesting species—kittiwake and herring gulls, gannet, guillemot, razorbill and fulmar petrel. A study was made of display as noted at different times, which gave Miss Littlefair full scope to show her artistic skill. The Countess of Albemarle presided and spoke highly of the excellence of the papers given, as well as of the group work throughout, coupled with the use of modern technique in presentation.

In addition to the usual Section lunch, held on September 7, four informative excursions were undertaken—a whole day to Robin Hood's Bay and Whitby (5th), and half-days to Fountains Abbey (6th), Sledmere House (7th), and to Harrogate to visit the Northern Antique Dealers Fair (8th).

SEEBOHM ROWNTREE'S CONTRIBUTION TO THE STUDY OF POVERTY[1]

by

R. W. DRINKWATER

Head of the Department of Social Studies, University of Hull

WHEN one considers the range both in time and content of Rowntree's work, it is all too clear that one cannot hope to compress within the range of a single paper any adequate appraisal of his achievements. Such an appraisal, covering as it must more than fifty years of work not only in the study of social conditions and of industrial relations, but in the concrete expression of knowledge acquired and faith held in activities of many diverse kinds, must obviously be itself the subject of a major work. This paper therefore confines itself to one single aspect of his work, his specific contribution to the formal study of poverty as distinct from his more general contribution to the improvement in the material conditions of life which have characterised these last sixty years. This aspect is chosen not only for its intrinsic importance as a significant step in the adoption of a more scientific approach to the study of social problems, but because it seems to afford the best opportunity of isolating a contribution which can be distinctively attributed to one individual from all the other manifold factors which have in combination brought about the enormous social changes since Rowntree's first work was published in 1901. It is perhaps too all the the more appropriate to return to such a theme at a time when recent trends in the evaluation of need with their inevitable impact on the concept of poverty, have found expression in public policy in an increase in National Assistance benefits explicitly attributed to the belief that those at the lowest level of income should have a greater share in the national prosperity, regardless of what may be the trend in subsistence costs.

> [H.M. Government [says the White Paper on Improvements in National Assistance (Command 782)] have reached the conclusion that the time has come when it is right to move to a higher standard, so giving those on National Assistance a share in increasing national prosperity.]

One notes that there is no reference here as there has previously been to movements in the cost of subsistence, or to any other objective test of need.

Whatever may be the immediate reason for this statement of policy, whatever may be one's views about the validity of the new standard, and its relevance to contemporary needs, one must assume that this represents some kind of common denominator of public sentiment. As such it may properly be compared with the Poor Law standards prevailing when Rowntree began his work in the last decade of the nineteenth century as an indication of the movement of ideas on need and poverty since that time. The comparison provides both the background against which his contribution has to be studied, and a broad indication of the significance of that contribution, for, although so many factors are involved in the process of social development that it would be idle to attempt to assess with any precision the individual weight of any one of them, it nonetheless remains a truism that effective change becomes possible only to the extent that the problems involved in it can be

[1] Paper delivered to Section F (Economics) on Monday, September 7, 1959, at the York Meeting of the British Association.

clearly identified and analysed. If we look back now to the nineteenth century we can see plainly enough how urgent was the need for such clarification. We should perhaps first remind ourselves of the general characteristics of the period so far as they are relevant to our particular theme. Here the analysis made by Professor Rostow in his recent Cambridge lectures is invaluable. Nineteenth-century Britain falls into the fourth of the five economic categories into which he suggests that all societies may be classified—the maturing society in which new methods and outlooks are spreading over the whole economy. The process of moving towards maturity, he suggests, generates the kind of social pressures which in turn enforce humane modifications of that process; society develops second thoughts about the merits of industrialisation as a unique and over-riding objective; changes in the structure, ambition and outlook of society lead up to a set of searching choices concerned with future objectives, choices set in a framework of protest against the human costs of the drive to maturity.

So far so good, but realistic choices leading to effective action are possible only to the extent that they are made in the light of accurate knowledge, and so far as poverty was concerned the degree of accurate knowledge about its incidence and causes, as opposed to easy and inaccurate assumptions, was slight indeed up to the beginning of the present century. The poor had indeed been a subject for concern for long enough before the studies of Booth and Rowntree, particularly if they should be 'deserving', if, that is to say, their behaviour should comply with the canons laid down by their social and economic betters; but concern had been tempered by the bland assumption that continued expansion would resolve all or most of their problems, save those created by individual fecklessness. Their needs had been theoretically defined by the classical economists as including, in the words of Adam Smith, 'whatever the custom of the country renders it indecent for creditable people of even the lowest order to be without'; but neither the Poor Law nor the wage system had provided for them at a level which made a decent existence possible. Innumerable philanthropic institutions existed, and the Charity Organisation Society was rallying to the call to make philanthropy more scientific. But concern was still essentially concern for 'the poor' as an established social category amongst whom some few might with appropriate moral guidance and discriminating aid be encouraged to lift themselves up by their own boot-straps, while the remainder must be coerced by the whip of less eligibility. The framework of protest was still essentially based on unaccepted theoretical hypotheses about the nature and development of industrial society. The stark reality of the existence of widespread poverty had become clear enough, but hard facts as to the 'who', the 'how many' and the 'why' were still conspicuously lacking, nor was there any clear conception as to how poverty might usefully be expressed in terms which would facilitate the search for clear answers to these questions.

With Booth and Rowntree, however, concern for the 'poor' changes to concern about 'poverty' as a social phenomenon, susceptible to a more exact study than had ever previously been contemplated, a study capable of facing society with incontrovertible evidence as to the nature of the choices falling to be made. While both made use of the techniques of large-scale survey covering the whole of a large area in such a way as to make a really comprehensive examination of the problem of poverty possible for the first time, Rowntree sought to examine the problem as one of general application to urban areas outside the metropolis—and in his later work, *How the Labourer Lives*, to rural areas also. More important still, he sought to establish a precision of measurement very substantially greater than that used by Booth. The means which he devised for this purpose constitute his signal contribution to the scientific study of the subject, and, at the risk of tedious repetition of what is already well known. it may be as well at this point to give some detailed account of those means.

In order to ascertain not only the proportion of the population of York living in poverty, but the nature of the poverty, he divided them into two classes

(*a*) families whose total earnings were insufficient to obtain the minimum necessaries for merely physical efficiency, a state which he defined as 'primary' poverty;

(*b*) families whose total earnings would be sufficient for the maintenance of merely physical efficiency were it not that some proportion of it was absorbed by other expenditure, either useful or wasteful, a state defined as 'secondary' poverty.

To ascertain the proportion in 'primary' poverty he sought to arrive at the minimum sum necessary to maintain families of various sizes in a state of physical efficiency. This sum, which constituted the 'poverty' line, was arrived at by a very close enquiry into the quantity, kinds, and costs of food deemed in the light of the best available evidence to be necessary for the purpose; by an enquiry into the actual rents paid, and by a detailed estimate of the necessary expenditure upon a limited number of other items regarded as absolutely essential, an estimate again based on the essential minimum purchased at the most economical cost.

The method used to estimate the numbers living in 'secondary' poverty was a purely subjective assessment of the conditions found by his investigators, based on evidence of obvious want and squalor, supplemented sometimes by direct testimony from neighbours or members of the household.

Having by means of such calculations assessed the numbers living in poverty, Rowntree went on to elucidate a cycle in the life of the labourer at the then level of wages of which the essential feature was a recurrent experience of 'primary' poverty at critical points where family income failed to meet the basic needs in childhood, middle life and old age.

His analysis of the basic problems of poverty rests essentially on these three concepts—the 'poverty line', the distinction between 'primary' and 'secondary' poverty, and the 'poverty cycle', and any assessment of his contribution to the study of poverty must therefore be based on the impact which they made.

To deal first with his calculation of the 'poverty line', we note that not only was this the means which enabled him to calculate immediately the striking proportion of people in York living in 'primary' poverty but that this yard-stick provided an objective standard which could and did serve as the working model for numerous other enquiries. His own assumption that York could be taken as representative of other provincial cities is certainly open to question in the light of more sophisticated statistical understanding, but any significance which this might have had was largely over-ruled by the extension of similar studies using the same basic standard to other provincial cities. Thirty-five years later, in 1936, R. F. George, in a paper presented to the Royal Statistical Society (1) outlining a new calculation of the poverty line, could say that all the post-war enquiries into the extent of poverty had used a standard based on the original Rowntree calculation, surely a sufficient tribute to the foundation he laid. If one adds George's own conclusion that the upward revision he suggested was almost entirely due to the then prevailing conception of minimum food requirements based on evidence new since the date of Rowntree's calculation, the essential soundness of the foundation is even more heavily underlined. In saying this, however, one is accepting the assumptions on which it was based, its relevance to the particular set of conditions in which it was used and to the particular function which it was designed to perform. One is not necessarily accepting it as a measure of poverty appropriate to a very different set of social conditions; and Rowntree himself showed in *Poverty and Progress* that he did not so accept it. Its value as a yard-stick is not however in any way diminished by later criticism of the rigorousness of the standard of subsistence laid

down, since it was clearly laid down not as a desirable level but as an absolute minimum for the maintenance of merely physical efficiency. The assumptions on which its viability rested were made explicit and the unlikeliness of their realisation was clearly shown.

> The above estimate [says Rowntree (2)] it should be particularly noted is based upon the assumption that every penny earned by every member of the family went into the family purse and was judiciously expended upon necessities;

Or again

> . . . at present the poor do not possess knowledge which would enable them to select a diet which is at once as nutritious and as economical as that which is here adopted as the standard. Moreover the adoption of such a diet would require considerable changes in established customs, and many prejudices would have to be uprooted.

And when he applied later the higher standard derived from his work on *The Human Needs of Labour* he returned to the same point:

> We must however bear in mind that no family which was without an accurate knowledge of the nutrient contained in various foodstuffs would be likely to choose a menu which enabled them to live in accordance with the given standard at such a low cost.

What we have here is a truly scientific concern to ensure that there should be no misconception about the implications of a definition. The 'model family' which could observe the standards postulated is a 'model' only in the strictly scientific sense, not in the popular sense of a model which either could or should be followed.

Rowntree was essentially concerned to ascertain the basic facts of poverty and to make them crystal clear in a manner which could not fail to impress itself on the opinion of his time. Could there have been any more graphic indication of them than his statement that 'the wages paid for unskilled labour in York are insufficient to provide food, shelter and clothing adequate to maintain a family of moderate size in a state of bare physical efficiency'; a statement reinforced by his description of 'merely physical efficiency':

> . . . a family living upon the scale allowed for in this estimate must never spend a penny on railway fare or omnibus. They must never go into the country unless they walk. They must never purchase a halfpenny newspaper or spend a penny to buy a ticket for a popular concert. They must write no letters to absent children, for they cannot afford to pay the postage. They must never contribute anything to their church or chapel, or give any help to a neighbour which costs them money. They cannot save, nor can they join sick club or Trade Union, because they cannot pay the necessary subscriptions. The children must have no pocket money for dolls, marbles, or sweets. The father must smoke no tobacco, and must drink no beer. The mother must never buy any pretty clothes for herself or for her children, the character of the family wardrobe as for the family diet being governed by the regulation, 'Nothing must be bought but that which is absolutely necessary for the maintenance of physical health, and what is bought must be of the plainest and most economical description.' Should a child fall ill, it must be attended by the parish doctor; should it die, it must be buried by the parish. Finally, the wage-earner must never be absent from his work for a single day.
>
> If any of these conditions are broken, the extra expenditure involved is met, *and can only be met*, by limiting the diet; or, in other words, by sacrificing physical efficiency.(3)

It was facts like these, based on a standard of the utmost stringency, coupled with the clear distinction between 'primary' and 'secondary' poverty which brought out incontrovertibly as was needed in the climate of the time, the extent to which poverty was due to causes completely outside the control of the individuals concerned. 'It was this', as Miss Hall (4) has pointed out in her book on *The Social Services of Modern England*, 'which constituted the real challenge to current beliefs about the attitudes towards the poor.' The facts themselves, so expressed,

made nonsense of any easy assumptions about fecklessness and irresponsibility as the major causes of poverty and one can therefore hardly underestimate the importance of the means by which they were brought out with such devastating clarity.

The initial conception of the 'poverty line' and its establishment at a particular level is only a part of the contribution; it is important also to examine the further use which Rowntree himself made of it and the modifications which he introduced into the standard. Here, since the ideas of the 'poverty line' and of 'primary poverty' are so intimately bound up with one another, it is important to note some lack of consistency in the use of the terms as between the various York studies. In *Poverty: a Study of Town Life*, the definition of primary poverty is crystal clear as I have already shown; primary poverty is inability to purchase the essentials for merely physical efficiency and the 'poverty line' indicates the income necessary for that purpose; in *Poverty and Progress*, the 'poverty-line' indicates the level of income needed to sustain a minimum human needs' standard derived from Rowntree's work on *The Human Needs of Labour*, a standard which is substantially higher than the old 'physical efficiency' standard, and a separate calculation is made of those living in 'primary poverty', using the 'physical efficiency' standard and making a comparison with the level of 'primary' poverty in 1899. In *Poverty and the Welfare State* the reference (5) is to estimating 'the proportion of the working-class population of York living in "primary" poverty, i.e. poverty due to lack of income, no matter how carefully the income is spent', and there is no reference to the maintenance of merely physical efficiency as in the original definition. Since the standard used in this work is a revised version of the 'minimum human needs' standard, clearly 'primary poverty' here is something very different from what was originally so designated, involving *inter alia* the inability to spend the amount included in the standard on items such as beer and tobacco.

While the change in definition may provide a trap for the unwary reader, it does of course emphasise the crucial problem of attempting to devise an objective standard of measurement of poverty appropriate to constantly changing social norms, and opens up the whole question of the boundary between 'primary' and 'secondary' poverty, between 'useful' and 'wasteful' expenditure, and between basic 'necessities' and 'conventional needs'. The extent of the problem becomes clear if we consider some of the more recent criticisms of the standards adopted in the early surveys. Thus, for example, Townsend in a paper on 'Measuring Poverty' (6):

> In considering all these poverty standards in detail, one cannot help feeling that they are too arbitrary. If clothing, money for travel to work, and newspapers are considered to be 'necessaries' in the conventional sense, why not tea, handkerchiefs, laundry, contraceptives, cosmetics, hair-dressing and shaving and life insurance? Are we indeed so sure that a list of necessaries must exclude cigarettes, beer, toys for children, Christmas gifts and cinema entertainment? The question of what were regarded or ought to have been regarded as necessaries was very rarely raised in any of the surveys.

Or, again from the same paper:

> In any event, the acceptance of a standard such as the pre-war poverty line or the Beveridge subsistence minimum implies that poor working-class people should and could live as social scientists and administrators think they should live. There has been little attempt to discuss the distinction between 'luxuries' and 'necessities' in terms of economic and social sanctions for spending behaviour, nor in terms of individual and class differences. And there has been no attempt to distinguish between the humanly attainable and the desirable in the pattern of family budgets.

One does not, I think, need to disagree with the sentiments which underlie these criticisms to feel that, whatever application they may have to others, they do considerably less than justice to Rowntree himself, and I would argue that in his comments on the original 'poverty line', in his modification of it in the 'human'

needs standard, and in his comments, implied if not direct, on secondary poverty, he did in fact go a very considerable way along the path which makes such an approach to the question of definition possible. I have already given some quotations in which he stated the assumptions underlying the standard originally fixed. Nobody reading them could conceivably think that he considered the standard either desirable or humanly attainable, since he expressly states that they are neither, and I should certainly find it difficult to suppose, when he says that attainment of the standard would require considerable changes in established customs, that he is making any adverse judgment of those practising them. The understanding which he shows of the extent to which the pattern of working-class life is conditioned by the circumstances in which it is lived and by irregularity of income, his recognition of the extent to which they are part and parcel of the whole broad problem of social welfare only to be resolved by far-reaching social measures, are sufficient indication to the contrary. More directly he himself introduced in the 'human needs' standard many of the very items which Townsend lists as desirable components; his allowance for personal sundries included such items as stamps, writing-paper, newspapers, wireless, beer, tobacco, presents, holidays, travelling, and though the allowance was arbitrarily fixed, yet it represents a token of what he considered to be 'necessary' elements in living at this standard. Elsewhere (7) he explicitly states his non-judgmental attitude in a comment on secondary poverty:

> . . . but if, on the other hand, the head of the household chooses to spend it (income above the poverty line) on himself, either on drink, cigarettes, gambling or other personal expenditure (*which I am not concerned here either to condone or condemn*) then although his income may be comparatively high, the standard of comfort enjoyed by the family may be very low.

And if that is not enough we may note too the specific comment on the 'human needs' standard (8)—'I feel strongly, therefore, that my bill of fare cannot be called too liberal, though it might easily be challenged as not liberal enough.' It is true that, to quote Townsend again,

> many critics fastened on to the large numbers in what Rowntree called 'secondary' poverty as evidence of the need for moral regeneration, and said that these people lacked merely strength of will to pull themselves out of poverty . . . it was not appreciated that many in this class would have needed virtues of self-denial, skill and knowledge not possessed by any other class of society, if they were to spend their money as it was thought they should spend it.

One would indeed have expected to find that the stark facts about primary poverty would be too strong a draught for some to take without the assistance of a soothing balm, but this would scarcely justify criticism of one who was at such pains to qualify his definitions at almost every point.

And yet perhaps one may fairly regret that Rowntree did not feel able to embark on a more explicit treatment of the problem of secondary poverty such as might have brought out more fully the significance of the reference in his original definition to 'useful' as well as 'wasteful' expenditure, and set it over against the specific reference to drink, betting and gambling as causes of secondary poverty. It will be remembered that, following Booth, he grouped his subjects into a number of classes according to income, classes A and B being below the 'poverty line', and class C the group immediately above it. When one sets his calculation of the numbers in this group over against the various qualifications he makes as to the capacity of working-class people to expend income according to the strict standard postulated by his definitions, whether in 1899 or 1935, it becomes clear that he was very close indeed to the crux of the matter. A detailed budgetary study of this group had it been possible, would have provided precisely the kind of evidence called for by recent students of poverty who emphasise the importance of attempting to define

by reference to actual patterns of consumer behaviour the standard of efficiency reasonably to be expected of those living near the margin. Such a study would have been far more valuable than any number of generalised qualifications in bringing out the amount of expenditure 'in the truest sense useful, though not necessary for the maintenance of merely physical efficiency', to use Rowntree's own words, which contributed to the existence of 'secondary poverty'. To this extent the door would have been less wide open for misconception than it was left by the express abandonment of the attempt to assess the incidence of secondary poverty in *Poverty and Progress*. Nor would this have introduced any more subjective element into the situation than was to be found already either in the 1899 study when the assessment of 'secondary poverty' was a purely subjective one, or in 1935, when the 'human needs' standard already included so many items which could be regarded as strictly 'non-essential'.

I come finally to some comment on the 'poverty-cycle' before attempting to sum up what I have had to say. The exact definition of a poverty line and the distinction between primary and secondary poverty provided the tools of analysis necessary to indicate the extent of poverty at a given time, and by isolating those in poverty, particularly primary poverty, gave the opportunity of measuring the relative importance of various causes of poverty. The elucidation of the cycle of poverty made it possible to see more clearly the extension of the problem over time. By setting the standard wage rate for an unskilled labourer against the poverty line Rowntree was able to demonstrate that at any point when a man at that wage attained a given degree of family responsibility, specifically when he had three children dependent on him, he and his family would be under-fed, and that when wage-earning ceased he would again be under-fed. Thus any particular individual would run the risk of deprivation in childhood, in early middle life, and in old age. The particular number shown at the time of the study to be in a state of poverty represented only a proportion of all those who could expect to be at some stage in such a state, and any attack on the problem would have to take account of these facts. This analysis, developed subsequently in *The Human Needs of Labour*, as the basis for a programme of action to improve wage rates and introduce a system of family endowment, and returned to again in *Poverty and Progress*, represents the more concrete outcome of work whose primary purpose was to elicit facts. It brings us squarely into the field of social action where it is manifestly impossible to distinguish the particular significance of one particular contribution. But one cannot doubt that the emphasis which it laid on the relationship of poverty to dependency must have played a great part in stimulating the action which was later developed to offset the problems involved. Even though, for example, Eleanor Rathbone found some of his particular arguments unconvincing, she adds (9) that 'there is no one whose works afford richer material for demonstrating the failure of the theory of a uniform family wage to fit the facts', and cites in support of it the conclusion which, as she says, 'leaps to the eye' from his figures and those of Bowley following him, 'that by far the greatest cause of primary poverty is the failure of the wage-system to adapt itself to the needs of the variously sized households actually dependent on the wage-earner'.

How then should one sum up the contribution to the study of poverty of a man who over a period of fifty years published three major studies of the subject along with numerous ancillary works bearing on it? What I have suggested is that the main essence of his contribution is to be found in the three major tools of analysis which he developed in his first work, and which enabled him both to clarify for that time the issues to be faced and to hand on to his successors the means by which further clarification might be obtained. Beyond this, however, by the way in which he used the tools himself he continually pointed the way to a widening of the scope of consideration and laid the foundation for the conception of poverty which forms the

basis of the most recent approaches to the problem. We may easily looking back over his work from our present standpoint see ground for criticism here and there, of what he may or may not have done. The P.E.P. Report of 1952, 'Poverty Ten Years after Beveridge', for example, contains much detailed criticism on grounds both conceptual and methodological of his latest work, modelled closely as it was on the earlier ones. But it is after all the common fate of men who are pioneers in a field of work and who for so long continue in it that their work should become the target of the more exacting standards of criticism which it has itself done so much to make possible. If we accept such criticism with a proper sense of historical perspective, we can yet see that the basic principles laid down by Rowntree in 1899 refined in their application in the light of new techniques, new insights into human behaviour, and changing social conditions, remain the essential foundation for the work which still needs to be done in this field.

REFERENCES

(1) *Journal of the Royal Statistical Society*, Vol. C, 1937, p. 74.
(2) *Poverty: a study of Town Life, passim.*
(3) *Ibid.*, pp. 133–4.
(4) *The Social Services of Modern England*, 1959.
(5) ROWNTREE, S. & LAVER,—(1950): *Poverty and the Welfare State*, p. 22.
(6) *British Journal of Sociology*, Vol. V, 2, 1954.
(7) *Poverty and Progress*, 1941, p. 124.
(8) *The Human Needs of Labour*, 1918, p. 125.
(9) *The Disinherited Family*, 1927, pp. 19 and 27.

THE PSYCHOLOGY OF LUCK[1]

by

PROFESSOR JOHN COHEN

I

Luck and uncertainty. The ubiquitous belief in luck has its birth in the effort to control life's uncertainties: in defence against unknown hazards and to ensure that good fortune does not pass us by. As societies move from a primitive to a more civilised state, their uncertainties do not diminish; they only change their character. So the idea of luck survives without loss of vigour. As a response to uncertainty, this idea must be studied in the context of psychological probability. In 1954, at the Oxford meeting of the British Association, I described the first studies of psychological probability inaugurated at Manchester (1). Since then, we have enquired further into those modes of thought and behaviour which characteristically occur in states of uncertainty, such as, for example, choosing, estimating, predicting, inferring from samples, risk-taking, and arriving at decisions in gambling situations (2). Whenever possible, we attempt to identify features which are typical of different stages of mental development, for an understanding of the detailed course of mental growth is educationally of immense importance, especially in the preparation of the young for science and mathematics.

It is impossible to summarise these investigations in a few sentences, but I would like to draw two general inferences. The first is this: no idea is so alien to us as that of randomness. We can, it is true, conceive of randomness as something devoid of order. We can imagine a sequence that lacks system, and is therefore unpredictable. But our preceptions, thoughts, preferences, decisions or actions are never themselves random. When we construct mechanical or electronic randomisers, or prepare numerical lists which we assume to be random, we are able to do so by withdrawing our mental participation from the randomising procedure. Any intervention on our part introduces a pattern. If we try to write down numbers or words 'at random', we find that the result is marked by meaningful linkages between the items. Indeed, the sequence of choices made by the youngest child who can understand speech is invariably patterned. Even if he merely has to guess in which hand a sweet is hidden, his successive choice of right or left hand reveal a system of preferences which is characteristic of children of his age under the particular conditions of the experiment. There is variation from child to child, but the choices are never random.

We can formulate this in broader terms by saying that our mental life is characterised by a constant search for meaning, an endeavour, implicit or explicit, to make sense of our existence, of the outside world as well as of our private experience. If so, no man-made machine can hope to serve as an adequate model of the human mind, however generously we interpret the word 'machine'. I do not, however, wish to suggest that electronic or other models of the brain (in so far as they are not toys masquerading as models) cannot throw light on certain limited mental functions. The work of Grey Walter (3) and others testifies that they certainly can.

This leads to my second inference. Studies of psychological probability offer some support for the idea that our minds act as implicit and unwitting 'calculators'. But the tendencies which govern mental operations in psychological probability

[1] Paper delivered to Section J (Psychology) on September 3, 1959, at the York Meeting of the British Association.

are distinctive and not to be identified with the rules of mathematical probability. These tendencies refuse to be reduced to a single or simple formula, and the sanguine belief that psychological probability can be embodied in an axiomatic system betrays a lack of familiarity with the complexity of the empirical material with which such a system would have to cope. The 'rules' of psychological probability change in systematic fashion from one stage of mental development to another. In certain circumstances they display properties analogous to the additive and multiplicative properties of mathematical probability. In other circumstances they diverge in a meaningful and consistent fashion in a manner peculiar to themselves.

II

The meaning of 'luck'. Expressions for 'luck' in different languages introduce nuances that are hard to capture in any particular tongue, and even those who speak the same language do not necessarily mean the same thing by the word 'luck'. A survey of English usage reveals two main conceptions of luck: (i) an unearned advantage, and (ii) a fortuitous influence from outside. These two conceptions are to some extent antithetical. For the first signifies a determined fate, a favourable (or unfavourable) property of a person (object, number, day), as exemplified by such expressions as 'he is a lucky man', 'luck is on his side', 'he has lots of luck', 'it is his lucky day', 'everyone has an equal amount of good or bad luck'. The contrasting notion refers to events which are unregulated, indiscriminate, unexpected, unpredictable and intrinsically fickle and capricious, as when someone says it is 'outside (or against) the laws of probability' or it is 'just a matter of luck'. This second conception of luck as something fortuitous is allied to the idea of 'chance', and it is not found among archaic or deeply religious peoples, who believe that everything is governed by a supernatural agency or divine Providence, down to the minutest particular of an individual's life. The two notions are fused in traditional artistic representations of *Fortuna*. Just as the idea of luck, in the sense of unknown chance or unpredictable cause, enters late in the history of human culture, so it appears relatively late in the mental development of the individual.

III

Survival of ancient beliefs in luck. The venerable belief that certain intervals of time are propitious is found in many writers of antiquity (Hesiod, Plautus, Pliny, Martial, Petronius and others), and there are similar bliefs which relate to lucky colours and numbers. The Thracians, according to Pliny (4), used to lay aside a white or black pebble for every day of their life according to whether it was lucky or unlucky. Petronius (5) describes the doorpost of a house on which lucky and unlucky days were distinguished by knobs of different colours. Since any change in the course of natural events seemed ominous to archaic man, the days when the moon passed from one quarter into the next were unlucky, and the activities to be avoided on such days were enumerated by Babylonian scribes (6). The forerunner of our calendar was an astrological list of lucky and unlucky days to mark the occurrence of striking events. Such a list served as a calendar until the Babylonians and Assyrians, about 2000 B.C., divided the year into twelve parts with thirty days in each (7). Custom has preserved some such beliefs though their original meaning has long been lost. Many people, for example, still believe that marriages in May are unlucky, a belief which originates in the Roman Lemuralia, funeral rites to propitiate spirits of the dead which were thought to wander at night and torment the living.

This belief in lucky days, colours and numbers has retained its vitality. I have found that young children of eight or nine years of age have, on the average, one lucky number, day and colour. One in two of university students (among our

samples) has a lucky number and one in three a lucky day or colour. Among children, the luckiest number seems to be seven; the luckiest day Saturday or Sunday; and the luckiest colour, red, followed by blue. Numbers, days and colours are thought lucky by the children because they are associated with pleasing things or events. One small girl said that two was her lucky number 'because I only want two babies when I grow up'. Another said that Sunday is lucky because 'my brother's fiancée comes and I like her'.

The magic of numbers, I might add, has not been without consequence in the history of science and it has not yet lost its potency. Huyghens' faith in 'six' as the perfect number, which led him to the conviction that Saturn could have only one planet, is hardly more fantastic than Hobbes' geometry, which 'plussed or minussed you to heaven or hell', or the attempts of Leibniz to apply geometrical principles to ethics and politics (8). This Cartesian mirage of an Admirable Science of numbers which would solve all human problems still finds its ardent devotees in contemporary psychology.

Apart from being attached to days, colours and numbers, luck is also felt to be a property of persons. This may be illustrated by replies to the question: If 100 people each had the chance of drawing one ticket from a box of 100 raffle tickets including a single winning ticket, how many would be lucky and draw the winning ticket? It is made clear, of course, that the ticket drawn is always replaced before the next draw. The average child of eight, I find, thinks that about 50 of the 100 would be lucky. At the age of 14 years, this 50 is reduced to 5, and, among students, to 2. The reasons given for the guesses make it evident that some people are believed to be lucky and therefore draw the winning ticket; others are unlucky and do not.

Replies to a second question: If you were allowed more than one draw, how many would you need to be lucky? showed that all three age groups again overrated the chance of success. A third question: Do you think *you yourself* will be lucky? brought an affirmative answer from 25 per cent of the youngest group and from 10 to 12 per cent of the two older groups. Women evidently feel themselves to be luckier than men: 12 per cent of the former (students at Training Colleges) thought they would be lucky as compared with 7 per cent of the latter. Some of the younger subjects thought they won (or lost) games because they were lucky (or unlucky). Others thought, on the contrary, that they were lucky (or unlucky) because they had won (or lost) a game.

A proportion of the older ones said they were lucky because they had been successful without effort (sometimes *with* effort), an interpretation of luck in terms of 'unearned advantage' which we have already met in other groups, but a larger proportion identified luck with fortuitous chance—the second conception discussed above.

IV

Lucky devices. The belief, encountered alike among primitive peoples and in mythologies of antiquity, that man's fortune is carefully controlled, generated a host of luck-bearing devices for influencing the controlling power. Amulets were supposed to provide continuous protection against evil, whilst the talisman could bring good fortune as well as guard against some specific object or disease. The most common form of amulet was a phallic or other obscene image, although anything strange which caught the eye was felt to be protective. Some amulets were worn openly, others in secret. Others, again, took the form of sacred writings, shapes or numbers. The phallus was so frequently used as an amulet that it acquired a special name for itself, the *fascinum*, and 'to fascinate', until the end of the seventeenth century, signified to produce the effect of the 'Evil Eye'.

One of the most curious of lucky charms is the caul or membrane, popularly known as the 'silly-how', which sometimes envelops the infant's head at birth.

This was believed to safeguard the infant against disease and accident, especially drowning, and guarantee his success in life. Midwives sold it to lawyers, who thought it rendered them more gracious in pleading a cause. In *The Times* of the last century advertisements frequently appeared offering cauls for sale at high prices. On 9 March 1820 *The Times* carried the following notice:

A child's caul to be disposed of. The efficacy of this wonderful production of nature, in preserving the possessor from all accidents by sea and land, has long been experienced, and is universally acknowledged: the present phenomenon was produced on the 4th of March inst. and covered not only the head, but the whole body and limbs of a fine female infant, the daughter of a respectable master tradesman. Apply at No. 49, Gee-street, Goswell-street, where a reference will be given to the eminent physician who officiated at the birth of the child.

Luck-bearing devices are specially evoked by circumstances of hazardous uncertainty. Thus the Melanesians employ no magic when they fish in the lagoon, where all contingencies are under their control, but they employ an elaborate ritual for luck in fishing in the open sea which is a highly perilous enterprise (9). Innumerable such rituals are encountered among obsessive persons everywhere, for they live almost constantly in a state of psychic emergency. Symbolic devices for ensuring luck and banishing ill-luck are particularly common among gamblers. For example, it is unlucky while playing to turn your back to the moon or to use borrowed money, but to play with money that has been placed on the altar at Christmas is lucky.

V

Measuring luck in terms of possible achievement. (*a*) A measure of the effect of a belief in luck may be obtained by comparing the performance we ordinarily expect to achieve with the performance we should expect to achieve if we were lucky or unlucky. The subject first makes a realistic estimate of his likely performance. He then makes four further estimates of his likely performance if (i) lucky, (ii) very lucky, (iii) unlucky, and (iv) very unlucky. (In an experiment the order in which the estimates are made is randomised.) Experimentally we can compare such different estimates of success in a variety of tasks, for instance, throwing a ball as far as possible, running a race, or taking a long jump. It appears that, in tasks of this kind, when we expect to be lucky we hope that our performance will be improved by some 6 to 12 per cent. An expectation of extraordinary luck implies an improvement of 12 to 26 per cent. Expectation of unluck means a deterioration of 15 to 40 per cent, and of very bad luck of 17 to as much as 80 per cent. Thus luck and unluck are not thought of as affecting performance symmetrically about a realistic average. The expected decrement due to unluck is about three times as great as the expected increment which luck is expected to bring. This does not violate common sense, for there are generally thought to be more factors which might impair performance than improve it. A further point that emerges is the possible effect of age. It seems than an increase in age tends to heighten the optimism of luck and deepen the pessimism of unluck. The values on which these interpretations are based are set out in Table. I.

(*b*) A related aspect of the effect of luck may be measured in terms of the proportion of trials in which the subject expects to succeed (10). First the subject estimates how many times (in, say, 10 attempts) he will succeed at a given task, and this proportion can be converted into a psychological probability by expressing it as a fraction of unity. Such an estimate is normally one which the performer considers realistic and which he thinks is most likely to occur in actuality. He then makes four additional estimates: how many times in ten attempts he would succeed if he were lucky, unlucky, very lucky, and very unlucky. Like the estimates by the first method these also provide a measure of luck as it is believed by the subject to affect his achievement.

In an experiment repeated with different groups, the subjects were given two types of task. The outcome of the first could not be estimated on any *a priori* basis, but only in the light of previous experience of similar tasks. It consisted of throwing a ball into a basket placed at three different distances. In the second type of task, the subjects estimated how many blue beads would appear if 10 beads were drawn at random from an urn containing blue and yellow beads. There were three different conditions: (i) 90 blue and 10 yellow; (ii) 50 blue and 50 yellow; and (iii) 10 blue and 90 yellow, i.e. with *a priori* probabilities of success of 0·9, 0·5, and 0·1 respectively.

TABLE I

Estimates (medians) of lucky and unlucky performance expressed as ratios of realistic estimates

Task	N	Lucky	Very lucky	Unlucky	Very unlucky
Long jump	76*	1·06	1·12	0·85	0·62
¼-mile race‡	122*	1·08	1·16	0·84	0·83
Ball throwing	112†	1·12	1·26	0·59	0·23

* Grammar School boys.
† Training College students.
‡ Reciprocals of the ratios for this task to make them comparable with the ratios for the other tasks.

I shall indicate briefly the principal conclusions to be drawn from this experiment. The subjects' estimates (medians) of success, expressed as psychological probabilities are set out in Table II. It is convenient to denote the psychological probabilities of success by the Greek letter ψ, with subscripts r, l, l', L, L' as follows:

Psychological probabilities of success

ψ_r = realistic
ψ_l = lucky
$\psi_{l'}$ = unlucky
ψ_L = very lucky
$\psi_{L'}$ = very unlucky

TABLE II

Psychological probabilities (ψ) of success

Throwing a ball from a varying distance		(2 ft)	(4 ft)	(12 ft)
very lucky	L	1·00	0·98	0·76
lucky	l	0·97	0·84	0·51
unlucky	l'	0·86	0·58	0·20
very unlucky	L'	0·66	0·38	0·09
realistic	r	0·98	0·79	0·41
Guessing number of blue beads		(p=0·9)	(p=0·5)	(p=0·1)
very lucky	L	0·90	0·81	0·57
lucky	l	0·80	0·64	0·39
unlucky	l'	0·57	0·32	0·13
very unlucky	L'	0·40	0·16	0·03
realistic	r	0·78	0·52	0·22

We note, first of all, certain features imposed by the scale of measurement. Thus as the lucky estimates tend to unity, so do the realistic estimates; and, similarly, as the unlucky estimates approach zero, so also do the realistic ones. Furthermore, when the task is subjectively easy, the realistic estimates tend to approach the most favourable ones and, conversely, when the task seems hard, they approach the least favourable ones. These features may be expressed in our notation as follows: (i) as $\psi_L \to 1{\cdot}0$, $\psi_r \to 1{\cdot}0$; as $\psi_{L'} \to 0$, $\psi_r \to 0$; and (ii) as $\psi_r \to 1{\cdot}0$, $\psi_r \to \psi_{L'}$; as $\psi_r \to 0$, $\psi_r \to \psi_{L'}$.

Secondly, the two types of task yield similar results, from which we may conclude that when two tasks are of comparable difficulty the various estimates of expected performance in the one resemble those in the other. In the case of the second task, we can compare the *a priori* probabilities with the corresponding realistic psychological probabilities, which are 0·78, 0·52, 0·22. The latter represent a contracted scale as compared with the former, suggesting a certain pessimism when the task is easy and an optimism when it is hard. This provides supporting evidence for a phenomenon repeatedly found by us in other experiments that there is a tendency to underestimate one's capacity when the task seems easy and to overestimate it when the task seems hard. The contracting effect appears also if the five types of estimate are made by the subject *after* his performance instead of before it. In such an experiment, with *a priori* probabilities of 0·7, 0·5, 0·3, the realistic values of ψ were 0·58, 0·46 and 0·34.

Thirdly, an examination of the psychological probabilities for the second task suggests that they are additive. Three generalisations may be hazarded:

(i) when $p=0{\cdot}5$ $\quad \psi_l+\psi_{l'}=1$
$\qquad\qquad\qquad\quad \psi_L+\psi_{L'}=1$

(ii) ψ_r (when $p=0{\cdot}9$)$+\psi_r$ (when $p=0{\cdot}1$)$=1$

(iii) ψ_l (when $p=0{\cdot}9$)$+\psi_{l'}$ (when $p=0{\cdot}1$)$=1$
$\quad\ \psi_L$ (when $p=0{\cdot}9$)$+\psi_{L'}$ (when $p=0{\cdot}1$)$=1$

and, similarly, when the values of p are interchanged. These may be gathered into a single generalisation, viz. $\psi_l^p+\psi_{l'}^{1-p}=1$, at all values of p and l, where p=the *a priori* probability and l and l' represent degrees of luck and unluck respectively.

Here, too, I should add that psychological probabilities derived from estimates made *after* performance also appear to have this additive property. Some distortion appears in the combination of the values for ψ_L and $\psi_{L'}$ due, presumably, to the contraction of the scale.

VI

The effect of luck in terms of frequency of success. The foregoing experiments have attempted to measure the difference between what we realistically believe will happen and what we should like to happen (or *not* to happen), but they do not tell us how often we think we shall be lucky or unlucky in any given series of trials. The frequency with which we think good or ill fortune befalls us is, however, an important aspect of the concept of luck. We can obtain a more or less direct measure of luck *as frequency* in this way: let the subject estimate, in physical units, the various performances he believes he could achieve with different degrees of luck and unluck respectively. Then let him estimate how often in, say, 100 trials, he thinks each of these performances would occur.

Analysis of data obtained from a large series of such successive estimates shows that neither variation in the tasks nor variation in the order in which the different estimates are made influences the relative magnitude of the estimates. It appears that when there is a range of possible outcomes of a situation, or a range of possible performances at a given task, we believe that the outcome or performance which

we regard as the most realistic will occur on about 52 per cent of the occasions, the lucky or unlucky outcomes on about 17 per cent, and the very lucky or very unlucky on about 7 per cent of the occasions. It is not as yet possible to say whether this symmetry of lucky and unlucky estimates about the realistic ones is partly or wholly an artefact of the measuring scale or whether it truly reflects the pattern of our beliefs.

The foregoing experiments may enable us to see in a new light our aspirations and actions in general, which are commonly guided by considerations which seem far from realistic. This is not necessarily a bad thing. For what we imagine we could achieve if we were lucky or fail to achieve if unlucky, may determine what we shall actually undertake. Our evaluation of the real world is shaped by our fantasies of it.

VII

Social repercussions of a belief in luck. The belief in luck acts as a social stabiliser by allaying discontent (11). It resembles, in this respect, that submission to horoscopes so disarmingly fostered by our national press, anxious to preserve the citizen's independence of judgment. If a man has amassed wealth merely because luck was on his side, he is safe from green-eyed envy; someone else might have been lucky. And the unsuccessful need not lose face, for they are merely unlucky. The German saying: 'Fools have all the luck' is balm to the academically and economically unsuccessful. The successful ones usually prefer to attribute their good fortune to effort and merit rather than to luck, if only in the interest of self-esteem, although modesty may require some lip-service to luck. Victims of criminal assault or other misfortune may likewise reassure themselves that they have had bad luck. It is then unnecessary for them to say that they deserved the blow. Particularly disturbing would be the thought that one had been selected by the criminal as his chosen victim. Of the three possible explanations: 'he chose me', 'I deserved it', 'it was bad luck', the last is the most comforting (12).

Apart from physical amulets and talismans (see Section IV, *supra*), there are conventional and institutional devices for gaining luck and avoiding ill-luck. For example, ill-fortune is attracted by praise of self and repelled by mockery of self. Hence the charm of self-disparagement. Disparagement by *others* is still more advantageous. The victim, by inviting scorn, gains luck and averts the Evil Eye. From provoking others to abuse you and thus transfer your ill-luck to them, it is a short step to employ a permanent scapegoat who, by constantly insulting his superiors, assumes their burden of ill-luck. Since a deformed or ugly person or dwarf is believed to be safe from the Evil Eye, and therefore lucky, he is ideally suited for the role of professional abuser. He transfers his good luck to his master while taking his master's ill luck upon himself and thus becomes an established mascot for an imperial house (13).

Many archaic societies employ professional vituperators with a talent for pouring forth a stream of abuse to protect the mighty. The abuse of the great at public festivals is an ancient prophylactic against ill-luck. It was not unusual for a host to revile his guests at the very moment that they ate at his table. In British universities a similar service is performed by a functionary known as the Public Orator, although the contumely with which he annoints the heads of honorary graduands is attenuated to a mildly belittling speech flavoured with faint praise. I venture to suggest that our political parties might engage professional vituperators (of other parties), thus freeing the energies of leaders and followers alike for the political task in hand.

Finally, I should like to draw attention to an interesting parallel between a phenomenon characteristic of the beliefs of individuals and one characteristic of a certain conception of history. In the experimental study of prediction we have

encountered the firmly held belief that people have stores of luck that can be depleted and replenished. If, therefore, one of two players has been winning for a time, he has used up his luck, whilst his opponent's store has remained intact; so the latter is more likely to win in the future. This paradoxical tendency for hope to grow and intensify as our affairs deteriorate may be regarded as an expression of the Monte Carlo fallacy (or what we call pseudo-subjective dependence), and we can draw an analogy between it and the cyclic conception of history. In the cults of Oriental-Hellenistic antiquity, the contemporary period was looked upon as decadent in relation to preceding epochs. There was (so it was thought) an inevitable sequence of successively inferior ages; as described by Hesiod, for example, the golden age of Saturn, the silver age of Jupiter, the brazen age of Neptune, the heroic age of Mars, and the iron age of Pluto. Even within the contemporary age, the moment was believed to deteriorate progressively. This was not a sign of pessimism but, on the contrary, of excessive optimism, for in a deteriorating situation, there are the seeds of regeneration (14). 'Things must get worse before they get better.' Hence the belief that the phase which precedes the millenium will be marked by the wars of Gog and Magog, uncurbed insolence, strife and universal chaos. This is the basis of the cyclical conception of time and history and the source of all our New Year celebrations. But there is a difference between the archaic societies of the past and the 'advanced' societies of today. The 'advanced' societies no longer look back nostalgically to a Garden of Eden or a Golden Age of Saturn. They have substituted in its place a series of Five-Year Plans. Paradise now lies ahead of us instead of behind us.

REFERENCES

(1) COHEN, J. (1954): *The Advancement of Science*, **11,** 333.
(2) COHEN, J. & HANSEL, C. E. M. (1956): *Risk and Gambling*. London: Longmans, Green.
(3) WALTER, W. GREY (1958): *Bull. Inst. Phys.*, July, p. 158.
(4) *Nat. Hist.*, **7,** 40.
(5) *Cena Trimalchionis* (ed. W. D. Lowe). London: Bell, 1905, p. 15.
(6) EISLER, R. (1946): *The Royal Art of Astrology*. London: Herbert Joseph, p. 149.
(7) WALLIS-BUDGE, A. (1930): *Amulets and Superstitions*. London: Humphrey Milford, p. 464.
(8) BREDVOLD, L. I. (1951): 'The Invention of the Ethical Calculus' in *The Seventeenth Century* (ed. R. F. Jones). Los Angeles, California: Stanford University Press, pp. 161 *et seq.*
(9) MALINOWSKI, B. (1925): 'Magic, Science and Religion' in *Science, Religion and Reality* (ed. J. Needham). New York: Macmillan, p. 32.
(10) COHEN, J. & HANSEL, C. E. M. (1957): *J. de Psychol.*, Jan.-March, p. 10; (1958): *Acta Psychol.*, **13,** 357.
(11) MERTON, R. K. (1949): *Social Theory and Social Structure*. Glencoe, III: Free Press, p. 139; AUBERT, V. (1959): *Inquiry*, **2,** 1.
(12) AUBERT, V. & MESSINGER, S. C. (1958): *Inquiry*, **3,** 137.
(13) WELSFORD, E. (1935): *The Fool*. London: Faber & Faber, p. 66.
(14) ELIADE, M. (1954): *The Myth of the Eternal Return* (transl. W. R. Trask). New York: Pantheon Books, p. 131; COHEN, J.: *Chance, Skill and Luck*. London: Harmondsworth: Penguin Books (in the press).

LIVING WITH SCIENCE[1]

ADDRESS BY THE COUNTESS OF ALBEMARLE

PRESIDENT OF THE ASSEMBLY OF CORRESPONDING SOCIETIES

It is a great honour for me to be President of the Assembly of Corresponding Societies this year; but it is an honour of which I would be even more unworthy were I not to acknowledge at the very beginning my lack of qualifications and my inability to give a learned address. I am myself a part of that 'educated ignorance' named by T. H. Huxley as the greatest of obstacles to be overcome, and all that I can do is to report on my condition, and to hope that the data may suggest a cure. If I can do this I am one of an honourable company, many of whom have perished in the attempt. I think of Laika, the Sputnik dog, of Abel and Baker, and of the four little mice!

De Tocqueville wrote: 'for a democracy to grow it must have citizens, a people who take interest in public affairs. They must have the capacity to participate and determine.' It is just this capacity that is the modern predicament—how can I aspire to be an intelligent citizen in this scientific age in which the very scale and complexity of knowledge would seem to require a mental equipment and formation which I do not possess, and modes of communication which are still to seek. Yet science is inescapably of my everyday world, in the home, the school, the workshop and the Council chamber—this predicament is essentially a modern one—all times are times of change but the acceleration of change and the vast increase of knowledge in our lifetime is what has posed the problem in its present acute form, and one remembers with a shudder Darwin's warning 'how largely extinction has acted in the world's history geology plainly declares'.

With the Greeks Science was a *Logos*—a philosophy apart from the things of everyday life and outside the knowledge and affairs of ordinary people—it played no part in the political scene. The growth of science throughout the so-called Dark Ages, was nurtured away from the civilisations which had seen its birth—the Egyptians, the Greeks, and from the Roman civilisation, which had swaddled it but added little to its concepts and practice; and when Europe settled down for a thousand years to consider what appeared to be the more urgent and real aspects of religion, the breaks through of Science, as for example with Galileo and da Vinci, were spasmodic—Science when it returned came flooding back from Arabia with the Moors.

Thenceforward Science grew and prospered but its concerns were with the few, with the explorers who were pushing back the known limits of the world and with the doctors and alchemists—Mathematics, Astronomy and Medicine were its chief growing points. Its impact on the arts and crafts was slight.

It was late in the eighteenth century when the Lunatics (so-called because they met in each other's houses on moonlit nights) brought science into the workshops and factories, and into the schools and colleges. Priestley inaugurated a college so advanced in scientific and liberal ideas that he had to flee to America; Boulton and Watt founded an engineering concern which flourished; Wedgwood the potter, and Darwin the physician through the intermarriage of their families were to beget a dynasty that is still of scientific eminence.

Thus Industry and Teaching began to accept and use Science. Of course, science as a discipline had been taught by varying mood and method in the ancient English and Scottish Universities, but with the younger ones founded at the beginning of the nineteenth century it began to have a clearer direction. Now, too, with the

[1] Address delivered on September 3, 1959, at the York Meeting of the British Association.

invention of machinery science began to obtrude upon the lives of ordinary people, the Luddite riots were the historical consequence of our first failure to make the social implications of science understood.

In the sphere of government one has to go back to the reign of Charles II for the first official recognition of the value of scientific knowledge—the newly founded Royal Society received its charter in 1662, and the Royal Observatory was established at Greenwich by the King, mainly to help the defence of the realm by providing observations and forecasts for the Royal Navy. But the recognition was meagre and slow in growing. This failure on the part of the Establishment was the cause of the founding in 1831 of the British Association whose avowed purpose was to obtain more attention for the objects of science and the removal of those disadvantages that impeded its progress. The year 1835 saw the establishment of the Geological Survey, a definite step forward.

From then on significant advances began to be made. There had, of course, by this time been inventions such as railways and steamships which demonstrated the value of translating theory into practice, although often against strong opposition. The Government began to perceive the political power inherent in applied science, although it was not until the turn of the century that Haldane succeeded in getting the Government to apply science in a fundamental way to defence problems and to promote scientific research in the interests of the nation; the industrialists saw opportunities to increase their business and their profits, to use heads and to save hands. One of the major impacts of science upon the public mind was undoubtedly the Great Exhibition of 1851 in its vast glasshouse in Hyde Park. Here all the inventions and scientific wonders of Britain and its Empire were gathered together and, for the first time, it was made clear to the general public that science had its tame genii as well as its awe-inspiring Titans, and that the former could be introduced to the domestic hearth. Science the handmaid was being born.

Eighteen fifty-nine—just a hundred years ago! no internal-combustion machine, no electricity, no anaesthetics nor antiseptics, no telephone, aeroplane or computer—the list is endless. The growth of invention, springing from the ever-spreading roots of scientific data and principles, is still accelerating so that like the White Queen, we cry, 'faster, faster', in order to keep in the same place. But throughout the latter half of the nineteenth century science was still a matter for the individual scientist or technician, and for the industrialist who, legitimately enough, wished to expand his business, or for the medical man in his pursuit of healing. As yet the public was not involved in the execution nor in the finance of scientific invention or policy—the citizen might benefit from the improvements to his way of living, he would accept gladly the idea of 'the inevitability of progress', but it was a progress within known and accepted forms—it was not yet a new heaven and a new earth, but just a more comfortable, better managed, steadily improving recognisable world. He had not yet to live with science, science was still his journeyman.

In 1902 the Prince of Wales, in opening the National Physical Laboratory, said, 'I believe that in the National Physical Laboratory we have the first instance of the State taking part in scientific research'—this marked the point of no return. Henceforth, willy nilly, you and I have become the patrons if not the arbiters of science—we are committed whether we like it or not. We are entitled, and indeed should feel impelled, to know what is being done in our name, and to what purpose. We bear a responsibility for the advancement of science, and for the uses to which everyday scientific processes are put.

But there is more to it than that—man for his fulfilment needs to come to terms with the society in which he lives, and our social environment today reflects in rate of change the sometimes frightening acceleration in scientific discovery and technical progress—we live in a society in flux, in a world so contracted that the

problems and needs of the farthest Continent are delivered with the milk and post on our doorstep every morning. Clearly the citizen cannot hope to be informed about the myriad ways in which science is fashioning his future, indeed the professional threshold is reached increasingly early by the average man and woman, but, surely, he needs at least to be aware of some of the forces at play, and to recognise that this brave new world demands from him an effort of mind and will, and a suppleness of outlook unparalleled in history. We are caught up in the web of our own ingenuity and we cannot leave the spinning of it to the Blind Fates.

Within society each one of us is also a member of that more intimate and infinitely more precious unit—the family. As parents we are concerned with the education of our young people; with education in its widest sense: by which I mean not only instruction—the imparting of knowledge and training of skills, but also formation, the communication of standards, ideals and beliefs. In our lifetime the advance of science will modify the character of the work in most of the professions and occupations in this country—some appreciation of this fact is necessary if we are to give sound advice to our children. Of course, we want to see them prepared to take their place as thinkers, planners, workers in a society penetrated by and dependent on technical skills; but we must listen to educationalists, and scientists themselves, who warn us of the dangers of over-early specialisation. We must inform ourselves of what science can and cannot do—we know it answers the question 'How?' but the question most often on human lips, and above all in the mouths of children, is 'Why?'. When the Carnegie United Kingdom Trustees visited the Carnegie Technical Institute at Pittsburgh the Provost told them, 'We develop well-informed, well-ordered, self-reliant thinking by integrating a humanistic-social programme with the basic scientific and professional curricula'; this was described, somewhat more succinctly, by the Director as 'de-emphasising know-how'. We and our children have to live with science not for science, and the children themselves may need persuading of this—science has captured the imagination of the young who think of all scientists as eminent and engaged in spectacular science-fiction escapades. They, too, need to learn what science is and does.

Today a special responsibility lies on the ordinary man and woman who, however remotely, has anything to do with the machinery of government, whether as administrator, councillor or committee member, or as a member of one of those organisations, of which there are so many, which try to influence and form public opinion. It is infrequent nowadays to reach decisions which do not in some measure and at some point require an assessment of scientific or technical data. And it is not only those who hold high positions in the State, or in business or industry, who are called upon to exercise this appreciation. One has only to name such questions as the pasteurisation of milk, the Salk vaccine, the fluoridation of water to bring the point home in every sense of the word. Or if one thinks of the racial problems, which perplex and trouble so many of us, one asks oneself if it would not be well to turn to anthropology and ethnology for guidance. I believe, too, that public business would be conducted more efficiently and on a sounder basis if more committee members had some understanding of scientific method. Statistics and factual surveys so often give the lie to opinions founded on generalised impressions, and a reverence for the ascertainable fact would harm none of us in carrying on the business of the Realm. It has been said, 'if ideas betray, facts do not'.

This country is producing scientists of the highest calibre, but that in itself is not enough. We are a nation that increasingly must live by our wits, and to survive we need to build express lines of communication from the laboratories to the factory floor, the farm, the hospital and the Council Chamber. I do not think we can feel any happier about the present state of our transport system in knowledge and ideas than we do about our goods system! I cannot judge how much blame lies

at the door of scientists, but I would hazard a guess that they are not guiltless; however, I do believe that those of us who are without scientific training have been too blind for too long to the nature and significance of what is happening in this scientific age: we have been existing not living with science, and it is time we became fully conscious. We ought to play a part, in so far as we can, in seeing that new ideas and inventions are made use of, and made use of ***promptly***, and we must not shirk the truth that our society must adapt itself, painful as that adjustment may be, or it will founder.

I now come to the crux of the matter. Granted all that I have said, what can the ordinary citizen do about it, how can he prepare himself to live intelligently in a scientific age, and what sources of information and instruction are available to him? Perhaps the first essential is for him to become aware of his predicament, to become seized of the fact that both nationally and internationally he lives balanced on a knife edge between peril and plenty. Secondly, he should have a general understanding of what is meant by scientific method, the collection of data and the checking of theories by facts. In the different sciences the criteria of validity may vary but the establishment and supremacy of the fact is common to them all. This is a far more difficult discipline for the human mind than is commonly admitted. It is revealing to find Darwin in his autobiography confessing, 'I had followed a golden rule namely that whenever a published fact, a new observation, or thought came across me, which was opposed to my general results, to make a memorandum of it without fail and *at once*; for I had found by experience that such facts and thoughts were far more apt to escape from memory'. Thirdly, I think the citizen should attempt to keep abreast of scientific developments. Obviously I am not suggesting that he can understand the new knowledge, indeed there is danger if the layman does not accept the proposition that many scientific ideas cannot be communicated in terms which he can understand; but he should look to the scientific world for information about the significance of the latest scientific theories in terms of human life and human experience, and he can be eager to discover and use the new techniques of applied science in his working world and in his private life. Maybe it is no bad thing to be gadget-minded, it augurs the open and the questioning mind.

Three objectives, then, for the citizen who attempts to live intelligently in an age of scientific revolution—awareness of the times in which he lives, understanding of the methods of scientific research, and determination to keep abreast of invention. It is a formidable programme but, happily, there are many agencies which come, and will have to come increasingly, to his assistance.

It is good to know that the British Association is adapting itself with such energy to our needs. The partnership on the new Area Committees between scientists and teachers on the one hand, and the adult education and the opinion-forming voluntary organisations on the other is both original and promising. One hopes enough money will be forthcoming to develop and extend these Committees so that in time the whole country may be covered. Remembering the demands upon scientists in research, for teaching, and, most urgently, for overseas development in the under-industrialised countries, I have often wondered if it was a pipe-dream to look to them to act as interpreters to us. I have wanted to cry, 'Come over to Macedonia and help us' but have feared to hear the reply of the Old Testament prophet, 'I am doing a great work and I cannot come down'. It is encouraging to learn that well over a hundred scientists have already joined the British Association panel of lecturers and I am sure that others will follow their example. All the same I think that the layman needs to show a sense of realism and to recognise that undue demands upon the time of scientists is not in the public interest. I hope associations will co-operate and combine to produce audiences. In my own part of the world I welcomed the initiative of the Soroptomists in gathering together the other

Women's Organisations and asking the Local Education Authority to lay on a combined school in Atomic Energy for them. This was an economic use of the lecturers' time. In the same way I wonder whether some existing scientific establishments could develop a service somewhat analogous to the Royal Institution's Friday Evening Discourses and Christmas Lectures, thus bringing the layman to the laboratory and saving the scientist from time-consuming journeys.

I believe that this section of the British Association can make a very special contribution. I spoke earlier of the need to understand something of scientific method and there is no better way to learn than by taking part in scientific investigations of however simple a nature. Many of the societies you represent are so engaged, and one would like to see a great increase in their membership. It was with a view to fostering this that the Carnegie United Kingdom Trust sponsored recently the publication by the British Association of a Directory of Natural History and Field Study Societies, including societies for archaeology, astronomy, meteorology, geology and cognate subjects. The list is an impressive one, and I hope it may be the means of attracting more people to join by making them aware of their opportunities; perhaps you yourselves could help by an active recruiting campaign. With a similar object in view the Trust has launched a new policy of giving financial help to recognised societies to further their activities. One would like to see the fullest possible use being made of this stimulus to expansion and you could be of help in making these offers more widely known. In the coming years one may look to see ever greater support for this section of the British Association Meeting as more people grow to understand the unique privilege offered here to the ordinary citizen: an opportunity to spend a week in touch with all that is most pregnant for our future, to become aware of the latest fields of knowledge conquered by the human mind, to have one's imagination stirred, one's mind stretched, and one's complacency shaken.

We are meeting this year in a Museum, so it seems apt to glance briefly at the part Museums can play in conveying an understanding of science to the citizen. Museums are intermediaries between the past and the future and they show us the transitions from phase to phase of an evolution. They are all scientific in matters of research and conservation, and in the museum world, it seems to me, one can still find a unified culture, the arts and sciences enriching and illuminating one another. Perhaps in this they can point a way for us? The science museums have a further rôle—their staffs can give advice and direction to amateur scientific activities, their exhibits can make explicit the history of science and its links with economic development, and can also help us to keep abreast. Just as an Art Gallery has, or should have, its section for contemporary art so the Science Museum should aim to exhibit the most modern developments in science and technology; this is done at the Science Museum in London by temporary exhibitions, and one would hope for the practice to become more general.

There are three main educators, the spoken word, the visual image and the written word. The inventions of printing, radio and television combined with universal education have made these accessible to all. Full use needs to be made of them in teaching us to live with science. I think it would be fair to say that the B.B.C. has discharged its responsibilities in this field in a substantial and imaginative way. The wide audiences it is reaching can be measured by the source of questions sent in for the Scientific Brains Trust which show a great range. Many of its programmes on sound and television have sparked off interests. I came across an example recently. The Extra Mural department of a University had made a number of valiant attempts to interest the general public in scientific subjects but the response had not been encouraging; suddenly a course on 'The Fundamental Problems of Pure Philosophy' was over-subscribed and had to be doubled; it appeared that the interest of the students had been stimulated by the Brains Trust

programme. I believe, also, that it is generally admitted that the current interest in archaeology springs from the successful programme 'Animal, Vegetable or Mineral'. This seems to me to suggest two things. First, that the quality of showmanship demanded by modern media is a real service to education and that to despise it is a form of 'hubris'; and, secondly, that closer co-operation between the television companies and the adult education bodies, perhaps on the lines of the British Association Area Committee, would be valuable. Having paid honour where honour is due, I must now say that I think there is a lot still to be attempted. Television, with its combination of sight and sound, seems to me especially adapted for conveying the wonder and drama of scientific research. It is an enkindling of the imagination that we need so badly, for the world today seems eaten up by boredom in the midst of marvels—one will look to the B.B.C., the independent Television Companies, and the Film Companies to mine this rich ore of human achievement, because science is the true adventure story of the twentieth century.

Science—the adventure story of the twentieth century! It is a reality one could miss if one looked only at the daily papers. It is, perhaps, dangerous to generalise in this way for there are exceptions, but what needs to be borne in mind is the number of single-paper readers, so that unless the coverage of science in the daily press is extensive there will be great masses of people left in ignorance of what is the most important single factor influencing their lives today, and their future tomorrow. The presentation of scientific subjects poses very difficult problems for the popular press, and there is certainly a shortage of talented journalists with sufficient scientific training to interpret the scientific revolution in ways calculated to arrest the attention of the butterfly-minded reader. All the same one would like to see more attempts being made, and I wonder if the Press is not in danger of underestimating how widespread the interest is. If one turns to scientific journals aimed at the layman the picture is rosier. There are five—*The New Scientist*, *Nature*, *Discovery*, *New Biology* and *The Penguin Science News*. I enquired about comparable journals in other European countries and found we were well ahead. France and Germany come next with three each, the U.S.S.R. has only one.

Sooner or later those who want to learn about science will turn to books, and here again the British Association has been forward in helping. In co-operation with the National Book League an annotated reading list has been compiled to guide the non-specialist reader. How far the layman can benefit from reading about scientific subjects unless he has some experience of science as an activity is a matter for conjecture. I heard of an interesting experiment carried out at the Natural History Museum. Exhibits were arranged illustrating the evidence for the general principles underlying the 'Handbook on Evolution'. One would like to hear how successful this had been and if many people benefited. Speaking personally I think I have derived most from scientific writers who have managed to convey to me, imaginatively, something of their personal experience as working scientists. I am thinking of Darwin in his autobiography, of Charles Snow in *The Search*, and of Loren Eisely in *The Immense Journey*.

So far I have been speaking of the urgent need to inform ourselves, and the resources available for this purpose, in terms of citizenship, but before I end I would like, for a minute, to think of the impact of scientific knowledge on the individual human person. For we all inhabit two worlds, a public and a private one, and I think that many of us are shaken and uncertain in our innermost being by what we imagine is the threat of science to our beliefs and our sense of personal worth.

'I, a stranger and afraid
In a world I never made.'

These are not comfortable words but they echo in the human heart. This fear, often unconscious, can act as a block in our minds and stop us from seeking to learn about the discoveries of science. We want to live in a familiar world irrespective of the fact that our familiar worlds may be cloud-cuckoo lands. That is not a religious attitude any more than it is a scientific one. The seeking of truth is the common basis to both, and the man of faith has least cause to fear. I can remember listening to the Reith lectures given by Professor Lovell with growing wonder and excitement, and I remembered Wells' dictum, 'Being is surrounded East, West, North and South by wonder'. For many of us the truest expression of this sense of wonder is found in the act of worship.

THE INFLUENCE OF PATHOGENIC FACTORS IN THE ROOTING SPACE ON THE DEVELOPMENT OF EVEN-AGED PLANTATIONS[1]

ADDRESS BY MR. W. R. DAY
CHAIRMAN OF SUB-SECTION K*

SPECIES of tree which are successful economically and so tend widely to be cultivated are necessarily adequately adapted to the climatic conditions of the regions concerned, at least within the limits of growth necessary to obtain marketable produce. Further, infestations and infections make no unduly severe burden; for this again is a condition for economic success. Under these conditions the area of cultivation, or maintenance, of a particular type of forest, while affected more or less strongly by current, or expected, economic demand, or other major aspect of policy, is largely a reflection of the distribution of available soils on which growth occurs which is capable of yielding profitable results. The influence of environmental factors on economic management is never perfectly reflected in policy for this is always in some degree speculative; and partly necessarily so in view of the inadequacy of our knowledge of present conditions and the difficulty of forecasting accurately what is involved in the future in terms of environment, economics or politics. Thus, even in the management of long-established forest, difficulties arise which are only partly soluble; when, however, as in Britain, forests are arising which are largely new in character it is inevitable that problems relating to the specific composition, tending and utilisation of the forest shall arise and be difficult to analyse, partly through lack of previous experience. Forestry, particularly under these conditions, is a type of adventure in which, not merely are the future conditions of the market somewhat speculative, but experience as to the conditions for production is often largely lacking.

Production is obtained through growth and is a biological process. If one assumes that, on the whole, and with certain more or less obvious exceptions, the species of tree chosen for cultivation in Britain are adequately adapted climatically, the aspect of environment from which problems which relate to growth most directly arise is the rooting space, and here I propose to discuss some of the characters of this in relation to the development of even-aged plantations, which still provide the predominating type of forest in this country.

Forestry is principally concerned, in utilisation, with the main stem as being usually the most profitable part of a tree; but plainly the rate of development of main stems, for any species, depends on the functioning of crown and root. It is obvious that crown and root are correlatives; the one depends on the other, and it is through this process of mutual influence that the tree grows. If the one is influenced adversely the other is also and the whole tree suffers. If it is assumed that factors which directly affect the crown, that is climatic conditions, infections, infestations, are not critically adverse, then the major adverse factors which control growth will be found in the environment of the root and will be determined by soil conditions. The nature of the forest as a developing entity is, thus, influenced and largely determined by these.

A forest as a natural phenomenon may, under certain circumstances, consist of trees of approximately the same age; for example, often when regeneration has

[1] Address delivered to Sub-Section K* (Forestry) on September 3, 1959, at the York Meeting of the British Association.

taken place after fire, or wind-throw; it is not natural, however, that it should remain even-aged if the full-cycle of development of the forest is considered. Even if the trees of which it is composed are of the same species and approximately of the same inherited character, local variations in environment ensure that differences in rate of growth and competitive vigour occur, which determine different life histories between the trees, and so differences in time of onset of economic maturity, debility with age and in local occurrence of regeneration, apart from susceptibility to infections and infestations. This process of development from a simple structure after mass regeneration to a more complex structure in the course of time, as the forest ages, takes place in many fashions and over very varying periods of time, according to the conditions which prevail locally and the species of tree concerned. The point of interest here is to note the strong tendency for a forest of simple structure, such as develops after mass even-aged regeneration, to become of more complex structure in terms of size, or age, of trees. It is necessary to remember that the change towards complexity may take a long time to develop. The rate of change and the character it assumes is, however, strongly influenced by soil conditions and it is with these that we are concerned.

Forest plantations in this country connect with mass, even-aged, natural regenerations in that they are almost always even-aged; also, they often, though not necessarily, consist of one species. Discussions of their silvicultural treatment in management in a moist temperate climate are usually based on certain assumptions; as well as on knowledge determined by experience: among these the following are of importance in connection with this discussion:

1. The population established is too dense to be maintained, and must be reduced as the trees grow larger.
2. Thinning is the most efficient way of doing this, both economically and biologically.
3. Ordinarily the response in growth after thinning will be towards the reformation of a more or less complete canopy.
4. Vigour of growth will be maintained long enough for this process to be continued until an economically worthwhile product is obtained.

These ideas are based on experience in forests on sites of fairly consistent and rather favourable fertility, in which the dominants, that is the trees from which the final crop will be taken, are never allowed to live to any really great age, and where there is a profitable market for thinnings. They refer thus to forest in which the final fellings take place at least during early maturity, using this word in a physiological sense and not as an economic term. Every forester of experience knows, however, that there are many occasions in which they break down. Thus there may be no response in growth after thinning adequate more or less completely to re-form the canopy, even though the plantation is still quite young; or rates of growth may be markedly different, from patch to patch, so that the maintenance of one consistent high canopy is not possible. The maintenance of vigour adequate to maintain an even-aged, more or less complete and consistent high canopy may thus not be possible and the necessity of accepting the development of a canopy of more complex structure may have to be faced. The development of multistoried, or irregular, forest is often brought about in this way. This is nothing new: but the problems raised in connection with this are of present interest in view of the stage of development of many of the plantations in Britain today, and the tendency often to regard a plantation of trees as something which can be manipulated spacially and almost mechanically so that a predetermined type of produce which will be obtained. The process of production in forestry is, however, through natural growth; it may be influenced within limits; but it cannot be ordered at will. Good growth necessitates a good environment. The full and perfect

growth of a forest is rarely, if ever, obtained, and in recognition of this, classification into Height Quality, or Site Index, classes is usually made. It is necessary to remember, however, that such a classification is a recognition of different degrees of prevention of a development which is inherently possible given appropriate conditions for growth. Factors which are growth-restricting become pathogenic when growth which is naturally attempted is prevented from taking place. Ordinarily in economic forestry in Britain, climatic conditions are reasonably favourable for the growth of the species used, and the critically adverse conditions mostly occur in the soil and act through their influence on root development and action, and the uptake of water and nutrients. One is concerned here, in part, with factors which influence the character of the root growing space, and in the remainder of this paper I wish to discuss the nature of some of these, and their influence on the growth of trees.

Some of the fundamental relationships which determine the manner of development of a forest concern the rate of change in demand, with increasing size of tree, for root growing space supplied with food and water. The attributes of this demand are in part geometrical, that is to say, they are specifications of needed space within which to grow; and they are partly qualitative, as prescribing the character of the geometrically specified space in terms of food, water and oxygen. If the actual conditions experienced fall below what is inherently needed, disease will occur simply because the environment is such that health is not capable of being maintained. It may be taken to be always the case that the root growing space sooner or later becomes an inadequate source of supply, and in this is to be found one of the basic causes of the decline in health of trees and so of change in forest structure and of successional development where this is allowed. A large tree obviously needs more room within which to grow, and a greater amount of supplies on which to exist, than a smaller one. It is also plain that ability to adapt bodily extension to environment—as, for example, by spread of root—is limited, and that accordingly ability to compensate for an inadequate growing space by such extension must also be limited. The many attempts by various means of cultivation to improve conditions for root growth in poor soils are a recognition of this: but even under conditions which are less extreme, the available site supply is often of critical importance in determining the limits in size of tree, referring here particularly to the trees of the high canopy, within which healthy development can occur.

When considering the development of plantations, interest is extended from the individual tree to the forest as a society of trees and the requirements of this society. An even-aged plantation is convenient for the consideration of this. It begins as a collection of small plants of more or less the same size, which partly through natural growth and competition, and usually partly through thinning, comes to contain progressively fewer individuals of increasingly larger size. The demands of such a developing plantation, from its environment, with increasing size and appropriate reduction in number of individuals may be considered in terms of volume development of canopy. A canopy can be considered abstractly in terms of a collection of equal-sized hollow three-dimensional shapes having a certain wall thickness; this representing the outer part of the crown in which most of the leaves occur. A cone with a circular base provides a convenient shape for consideration. The volume of wall of a canopy of cones of given wall thickness and angle of apex rises, with increase in size of cone, after the manner shown in Fig. 1. The rise is steep at first, but eventually becomes slight as the proportion of wall thickness to the governing dimensions of the cone becomes low. The indications from this are that, other things being satisfactory, as the crowns of an even-aged plantation increase in size, there is an increase in number of functional leaves and, because of this, necessarily in amount of functional root. The observations of Møller (1945) that there is an increase in the leaf area of a stand to an appreciable

extent, up to the time the canopy closes, but after that, to a much more slight extent, supports this: so also do those of Bonnevie-Svendsen and Gjems (1957) that litter yield increases with increasing basal area of stand. It is reasonable to equate increase of leaf area with increase in demand for supplies from the soil: further, if this is so, there should be evidence for it in the forest. The obvious decrease in wetness of marshy, or water-retentive soils on the development of forest may be cited in support; also the rise in wetness of soil which follows felling. Further evidence is to be seen in the increasing openness of mature canopy, with increasing dryness of site, in warm temperate pine forests in a climate with a hot dry summer: and plainly many other examples could be given.

Granted the conception that, at least during the early developmental stage of growth (Day, 1953), a canopy development which results from an increase in crown size, with a corresponding reduction in number of stems per unit area, is accompanied by a very appreciable rise in demand for soil supply, it can be seen that if

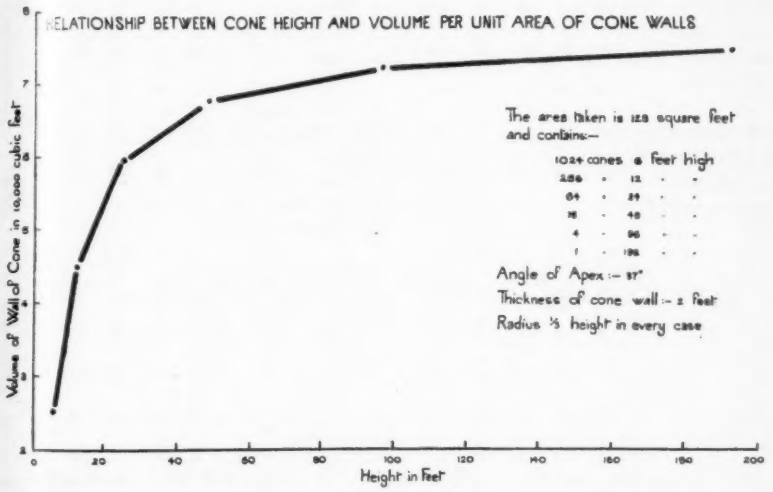


FIG. 1.

two sites which are situated similarly climatically, differ in terms of supply capacity for root development and action, a corresponding difference in stand development may be expected on the assumption that the supply capacity of the more limited size at least, falls below what the forest, in the process of its development, will tend inherently to demand. This is illustrated by two plots taken from one small block of Kerry Forest on the borders of central Wales (Fig. 2). The trees are demarkated by their girth, breast height. Both plots may be said to be in a similar general situation climatically: they both occurred on shallow soil which overlay fissured, easily draining Silurian shale. The plot for Compt. 64 represents a site which is very freely draining, both topographically and through the soil; while the plot for Compt. 60 represents one with a slightly deeper soil with some clay in the upper rock fissures and physically in a water receiving situation. The age, planting distance and species are the same. It will be seen that the plot for Compt. 60, with the better water conditions, was the better grown, both in terms of size of tree and consistence of stocking. The variations in condition between the plots reflect variations in condition of site and have to be accepted. The poorer growth in Compt. 64 also reflects a poorer root condition, and it has always been easy, at any time during the last ten years, to find some of the larger roots dead; though

only a very few of the larger trees have died. In 1957, the year of measurement, *Fomes annosus* fructifications occurred commonly on these dead roots.

A further example of variation in condition of stand with variation in site conditions is taken from Glenbranter Forest, Argyllshire (Fig. 3). It includes part of a group of poorly grown trees, many of which were dead. The better-grown trees had been brashed; but those in the poorer group were still untouched. *Rhizina inflata* was locally abundant in and on the edge of the poorly developed group. The diagram shows that the group of poorly grown and largely dead trees occurred in an area where root development was very shallow owing to the presence of a patch of highly impermeable soil. It will be seen, however, that even in the better-grown part of the area there are appreciable local variations in stocking.

Comparison of Stocking of Sitka spruce Plots Breast Height in inches from adjacent sites. In terms of Girth. Date of Measurement Spring 1957
Freely drained ridge site with shallow soil overlying fissured sandstone shale
Water receiving site with rather water retentive, shallow soil over fissured sandstone shale
C.t 64 Cefn Vron. Planting Year 1929
Kerry Forest
Mean Total Height - 35 ft.
Mean Girth B.H. - 15 ins.
Slope - 14° Aspect S.W.
C.t 60 Cefn Vron. Planting Year 1929
Kerry Forest
Mean Total Height - 50 ft.
Mean Girth B.H. - 21 ins.
Slope - 9° Aspect N.N.E.

FIG. 2.

It is, in fact, plain that, if the best-stocked part of the stand is taken as a standard, much of the rest, outside the area of failure, is comparatively of but moderate value in terms of timber production. These variations had not been caused by thinning, which had mainly been confined to trees in the dominated portion of the high canopy.

An example in which no fungus infection was observed is given in Fig. 4. This represents part of a stand of Norway spruce which grows by the Water of Ae, in Dumfriesshire, on an alluvial sand which overlies gravel. This stand showed a high survival rate on establishment; but great variability in rate of growth from tree to tree: it gave the impression of being a multi-aged stand, because of this. The figure shows that the distribution of size of tree in terms of girth was very irregular, so that the number of dominants and codominants is much higher in some parts than in others, reflecting the condition shown in the better part of Fig. 3. The soil on this site consists of about two to three feet of loamy sand which overlies

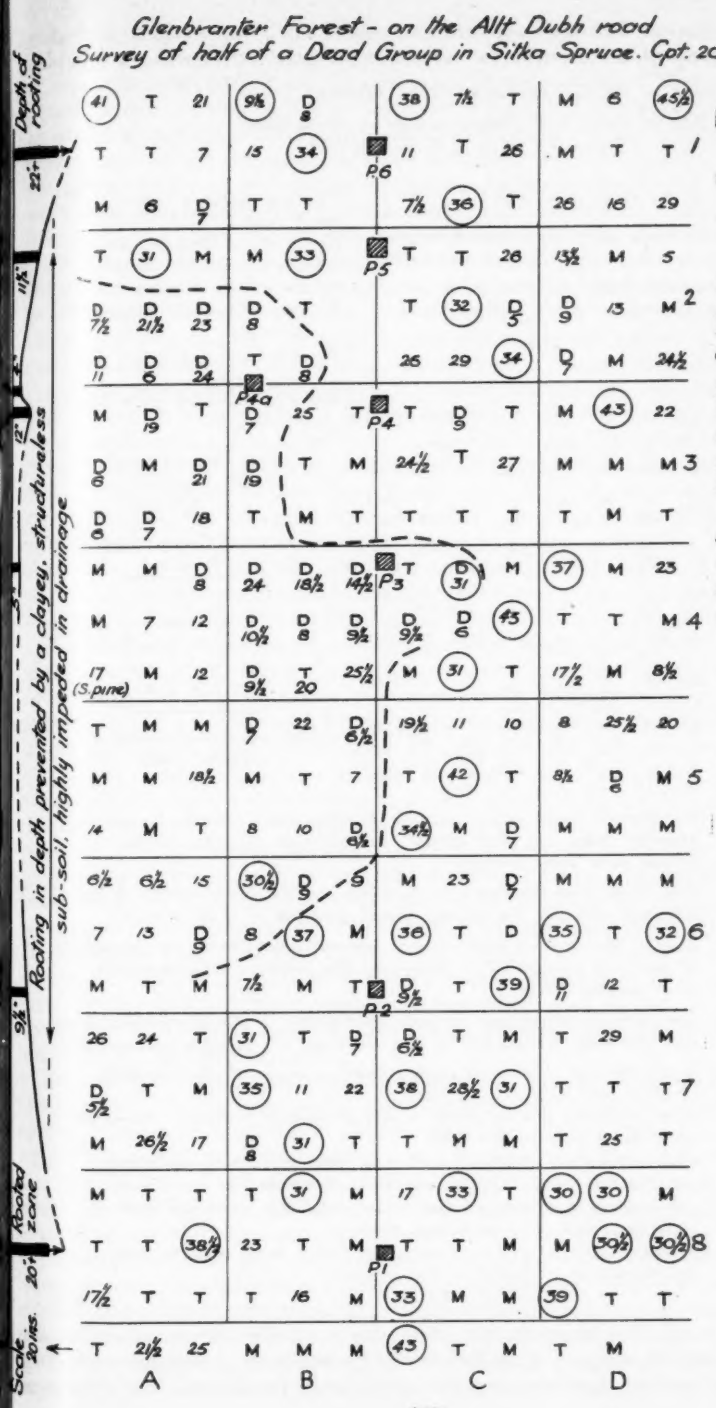
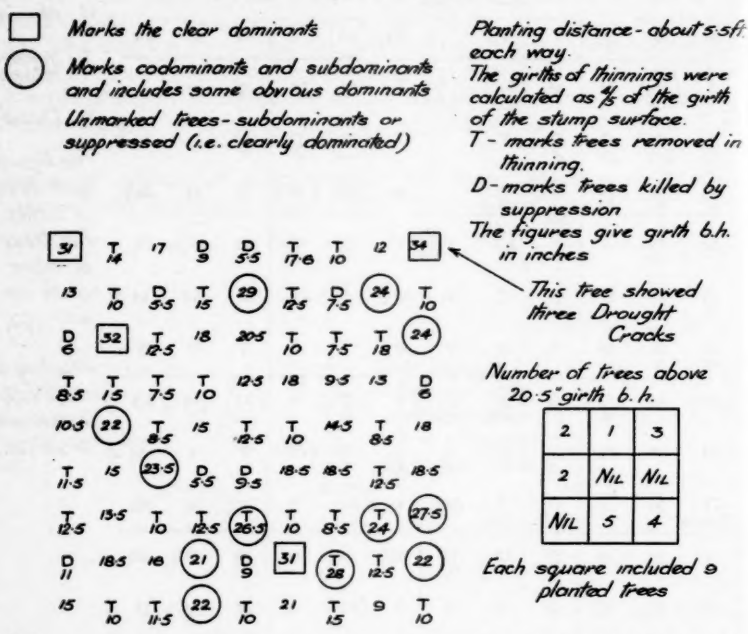

Glenbranter Forest - on the Allt Dubh road
Survey of half of a Dead Group in Sitka Spruce. Cpt: 20 P22
Depth of rooting
Rooting in depth prevented by a clayey, structureless sub-soil, highly impeded in drainage
Rooted zone
Scale 20 ins.
A
B
C
D
P1
P2
P3
P4
P4a
P5
P6
Position of soil pits
M Missing
T Removed in thinning
D Dead
The figures give Girth. Breast height in inches.
The trees of 30 or more inches girth are ringed so:- (37)
Planting Distance = 5½ x 5½ feet, rather irregularly in places.

FIG. 3.

a permeable gravel. The sand was intensely rooted in the upper 12 to 18 inches, but then sparsely rooted down to the surface of the gravel, over which a thin plate


Forest of Ae. Compartment Nº 135 Norway Spruce
Plot of Girth (B.H) Measurements in the surround
Surround of the L/C Thinning Plot
Marks the clear dominants
Marks codominants and subdominants and includes some obvious dominants
Unmarked trees - subdominants or suppressed (i.e. clearly dominated)
Planting distance - about 5·5ft each way.
The girths of thinnings were calculated as ⅔ of the girth of the stump surface.
T - marks trees removed in thinning.
D - marks trees killed by suppression
The figures give girth b.h. in inches
This tree showed three Drought Cracks
Number of trees above 20·5" girth b.h.
2 1 3
2 NIL NIL
NIL 5 4
Each square included 9 planted trees

Note:- 1. The larger trees were usually surrounded mainly by much smaller ones, so that direct competition by crowns for space was very limited.

2. Only three trees removed in thinning can be considered to have affected directly the crown growing space of a dominant.

3. Only in the bottom right-hand corner was there any possibility of serious competition between the crowns of dominants and codominants

4. The thinning obviously mainly was taken in the dominated trees and this was compelled by the manner of canopy development

The site – is an alluvial flat in a valley and is subject to flooding which is not long continued.

The soil – is a probably loamy sand, which probably overlies gravel in which there is a water-table.

The roots - show a shallow depth of well and intensely developed rooting (about 12 to 18 inches). Sinker roots go down below this largely unbranched: but spread out in an intensely branched thin plate at about 24 to 30 inches down.

The dominant Trees - have markedly irregular boles and very severe examples of drought crack occur.

FIG. 4.

of roots extended. The larger trees were mostly markedly buttressed and swollen at the base; further, some of them had suffered severely from drought crack (Day, 1954). There are thus three elements of interest in the condition of this plantation,

namely the great range in size between trees still living, together with the variation in standing volume from place to place; the occurrence of buttressing of the stem of the larger trees, and also of drought crack on some of these. These things are to be considered as based on the soil conditions prevailing. Generally effective characteristics are the shallow depth of abundantly rootable soil; the related poor branch development of the deeper-going roots because of the unfavourable character of the deeper sand and the underlying gravel; the highly fluctuating nature of the water table and, related to this, of the moisture content of the surface zone of well-rooted soil: the occurrence of drought crack is evidence for the latter points.

The characteristics noted here can be seen to varying extent in other stands of Norway spruce which occur on soils of at least moderate fertility, as judged by growth during the first decades, but which occur on soils which restrict the adequate development of the deeper-going part of the root system. There are thus examples on shallowly rooted soils which overlie impermeable till in Kielder Forest. An example of some interest is provided by the stand in Drummond Hill Forest in which a high-pruning experiment occurs. Here light and heavy thinning regimes have been practised side by side. Buttressed bases are absent in the lightly thinned area; but are plainly present on the openly spaced dominants in the heavily thinned parts. Moreover, the buttressed trees commonly show a bark necrosis within the flutes between the buttresses at the base of the stems. This type of bark necrosis has also occurred commonly on Sitka spruce in this forest, as well as elsewhere—e.g. in Kerry, Lake Vrynwy and Glentress Forests—and there is good anatomical evidence that, at least sometimes, it arises owing to a deficiency in water supply. (See Day (1959) for a discussion of this in relation to eucalypts.)

The phenomena discussed above seem to be related to a one-sided development of the root system in which the upper, more or less horizontally extending roots develop freely, but the normal downward extension of the root system is prevented to a greater or less extent. An important factor among the determining conditions is that the unfavourable subsoil shall be a poor source of water supply, at least periodically. Under these circumstances the distribution of roots bringing supplies to the base of the main stem becomes unbalanced and, related to this unsatisfactory distribution and the unfavourable supply capacity of the soil for water, there is periodically a supply deficiency which, in the lower part of the main stem, is felt more between the incoming roots than above them. Thus drought-cracks on the bole commonly arise above an inter-root space and, because of this, sometimes within a flute, the common site of the more serious aspects of basal bark necrosis on the bole in spruce. It may be proved by actual measurement that appreciable differences in moisture content of tissues actually occur in these places. Without thus denying that infections may sometimes play a part in the extension of the necrotic areas, it may be said that, in the type discussed here, soil supply conditions are basic for their development.

The examples put forward so far have been given to illustrate the following things: firstly, that the manner of development in an even-aged plantation of any species, in relation to growth in size of trees, is to a large extent a function of the supply characteristics of the rooting space. Any site will, thus, for any species of tree and conditions and manner of establishment, tend to show a particular type of development in growth of forest. Secondly, under any given climatic conditions, a restriction in rate of growth, as compared with what is known to be possible for the species, can only take place through prevention of growth attempted. The slower growth will occur thus through an environmental lack of balance between climatic and edaphic conditions: this implies the development of disease; though not, of course, necessarily acute, or even easily observable disease. Thirdly, that given these conditions, the pattern of development in a stand will reflect, to a large extent, the lack of balance between the climatic and edaphic opportunities for

growth. Variations in volume production; in age, or size, at which decay of dominants begins; in time of natural development of an understory; in the development of certain types of root and bark disease, all find a main basis for their development here.

I wish in the remainder of this address to give some illustrations, using Sitka spruce as a crop, of soil conditions under which disease of various types has occurred. Sitka spruce is used partly because examples were to hand, and partly because, under the climatic conditions which prevail in western Europe, it has to some extent proved sensitive to disease under the less-favourable soil conditions. The reference to soil conditions is elementary, based on field observation, and is concerned principally with physical conditions as affecting root distribution and development. Plainly, a much deeper analysis would be possible; but even if it had been made, it would take us beyond the scope of this discussion. The examples given all refer to soils which are more or less defective as media for root growth; but it is characteristic that the forester has usually to make do with sites on which the soils are of this nature. Such limitations of sites in terms of economic production should be recognised, and plainly conditions which affect the efficiency of growth, as the means of production of timber, are of basic importance in this connection. Some of the examples given were seen during a tour of Sitka-spruce plantations in north-western Europe, and I am much indebted to the Forest Services of the countries concerned for helping me to see these. These examples are used because of their intrinsic interest and also because they enable a greater variety of soil conditions to be illustrated within the range of one species of tree. Among other things, it enables examples to be taken from sites with deeply, or moderately deeply rooted soils. Relative shallowness of rooting depth is so common a characteristic of land available for forestry in Britain that, perhaps, one is apt to forget that deeply rootable soils have their problems in terms of root action and development. These problems largely centre round soil structure, as determining mechanical permeability by roots and aeration, and also the extent to which water and nutrients are available.

The three profiles in Fig. 5 illustrate three aspects of soil restriction, largely as determined by different conditions for drainage. All occurred in regions of moderately high (A), or high (B and C) rainfall. They also illustrate soils on which, during the first decades, satisfactory growth occurred. The critical feature in Profile A lies in the underlying bed of cemented till which prevents further root penetration in depth and gives up no water to the soil above. Water drains over the surface of this till; but not permanently and to a very different degree from place to place, so that the degree of natural subsoil irrigation varies greatly in abundance. This variation affects the amount of available water supply, so that a mosaic occurs giving more and less abundantly supplied patches, particularly during the drier growing seasons. Examination suggested that the degree of dying back of root systems was largely determined in this way, and the influence of the dry conditions in 1955, when much dying back of roots systems occurred, could be seen in the anatomy of affected roots. Other soil factors affect growth in this site; but restriction in rooting depth above the cemented material, combined with variations in natural subsoil irrigation, are critically determining causes of root disease and, through that, of variations in growth and general condition.

Profile C may be compared with A: the depth of rooting is very similar; both are acid soils; but the main defective zone in C is provided by a subsoil of gritty, stoney, freely draining material which also is adverse to root penetration. Growth was satisfactory on this site, for the first 30 years; but then trees began to die, or at least to suffer from die-back of the root. The profile shows that, in addition, there is a degree of consolidation in the central zone of the depth rooted sufficient to prevent any effective occupation of the soil. Basically critical conditions here

seem to lie in these two things; namely the freely draining, little water-retentive nature of the gritty, stoney subsoil, and the compaction of much of the B horizon, as restricting root occupation and determining water supply. The fact that this site is in a region of high average rainfall is no adequate protection; for even there really dry times occur during which critical conditions may develop: thus trees affected by drought crack occurred quite close by.

Profile B represents a case which, with variations as to rooting depth, soil acidity and nutrient status, occurs in many places. In this case, the soil parent material is a heavy clay of moderate acidity. The depth of drained, permanently rootable soil is shallow and any roots which enter the impermeable subsoil die, basically probably from lack of oxygen during the wetter periods when the clay fills with water and becomes putrid. This site came into notice partly because of local wind-throw and partly because there had been no adequate response in growth after

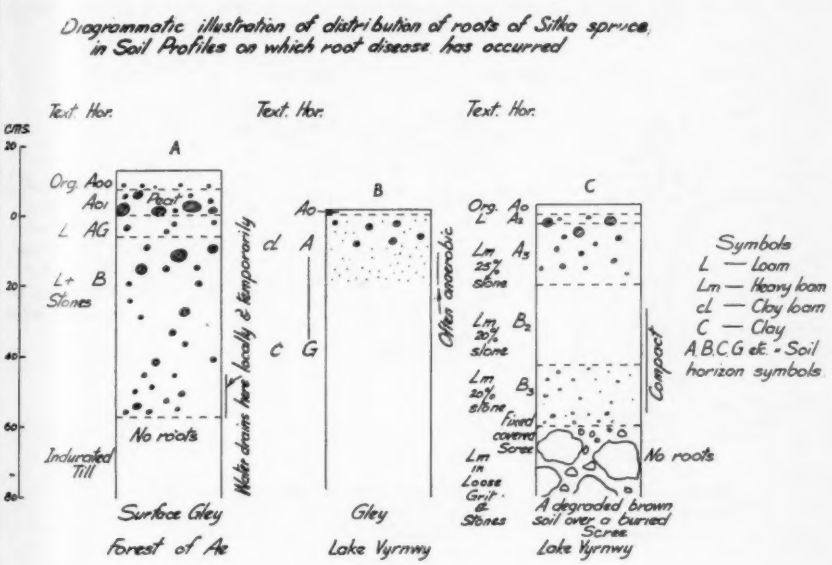


FIG. 5.

thinning. This is a site on which both excess and deficiency of water can provide trouble; it is also a site which naturally has a short period of efficient growth and in which the high canopy naturally begins to open out early, beginning with the hollow, wetter, places in which wet season waterlogging is most severe. There are indications for parasitism of the finer roots, even in the shallow-drained surface soil, species of *Pythium* probably being involved. It is plain, however, that the basic trouble lies in the physical make-up of the soil.

Profile 5B may be compared with Profile 6A, which represents a deeply rooted clay which is covered with a shallow depth of blown sand. This example is taken from the dunes area in Jutland, Denmark. Growth data for this site have been given by Hendriksen (1958). The profile was dug in a moderately heavily thinned stand, in a thinning experiment at Nystrup which, until the age of about forty-five years and until after the drought of 1947, did well. It then began to be severely attacked by *Dendroctonus micans*, the Giant Bark Beetle; *Fomes annosus* was also present. The critical features of this profile are, firstly, the low water capacity of

the shallow depth of sand; secondly, the deep and extensive rooting in the fissures of the underlying chalky boulder clay, which is naturally divided into large prismatic elements into which the roots do not penetrate. The clay is water-retentive, of good nutrient status, but in the main is not available for rooting, owing to the impenetrability of the large structural elements. Even when such elements are penetrable, little or no branching of roots usually takes place within them. Deeply rootable clay soils of this type occur on sites of good surface drainage. The limitation on their exploitability by roots limits their productivity in terms of growth and is a basic cause of root disease which, if sufficiently severe, results locally in death of trees, or of susceptibility to bark-beetle attack during or after severely dry growing seasons. Comparatively shallowly rootable soils with a clay subsoil may be much more productive and less subject to disease or infestation

Diagrammatic Illustration of distribution of roots of Sitka spruce under various soil conditions from sites on which attack by bark beetles (Dendroctonus micans) and root fungus (usually Fomes annosus or Armillaria mellea) had occurred

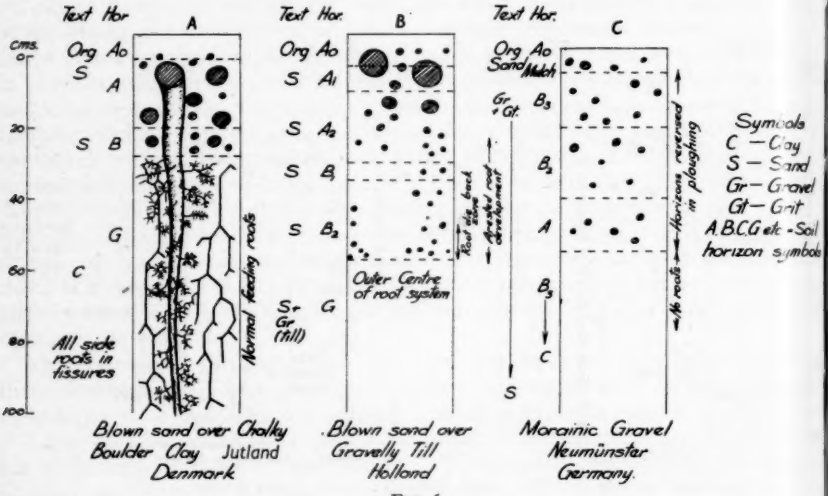


FIG. 6.

providing there is a good natural irrigation over the clay surface. Such irrigation cannot occur, however, in these deeply rooted clays for any appreciable period, or the fissures would close and so restrict rooting depth, giving a profile of the type of 5B, more or less.

The remaining profiles mainly concern sand soils; but 6C illustrates a freely drained, acid, gravel profile taken in one of the heaths in north-western Germany. This was deeply ploughed soil, the surface of which had been mulched by sand. A mixed stand containing Sitka spruce, Norway spruce, Scots pine and a few Douglas fir was planted, and this seems to have grown reasonably healthily if rather slowly at first; but at the time of examination, when 44 years of age, it was infested by *Dendroctonus micans*; *Fomes annosus* was also present. The diagram illustrates the effect of deep, complete ploughing on a soil which is not too consolidated, in making possible an abundant root development within the disturbed zone; this can be seen in many places on sand and gravel soils where such ploughing has been done in north-western Europe. It will be noted, however, that the undisturbed subsoil showed no root occupation. This subsoil is freely draining and a poor source of water supply. Thus, while other factors such as possibly nutrient status,

may come into this case, it is obvious that only as great a canopy can be grown, on a site such as this, as can be supported during dry years on the water available in the ploughed zone, and here is to be found a basic cause for the poor condition into which this stand developed.

An essentially similar case is provided by Profile 6B, which represents the type of root distribution of Sitka spruce, of about forty years of age, which is to be found on many of the sand soils which occur in Holland and Belgium, if fertile enough for this species and uncultivated. Had this profile been ploughed deeply a root distribution similar to that shown in 6C would have developed. The critical conditions in such soils lie mainly in, firstly, often low nutrient status, which can largely be remedied and often is by addition of fertilisers; secondly, in the naturally poor

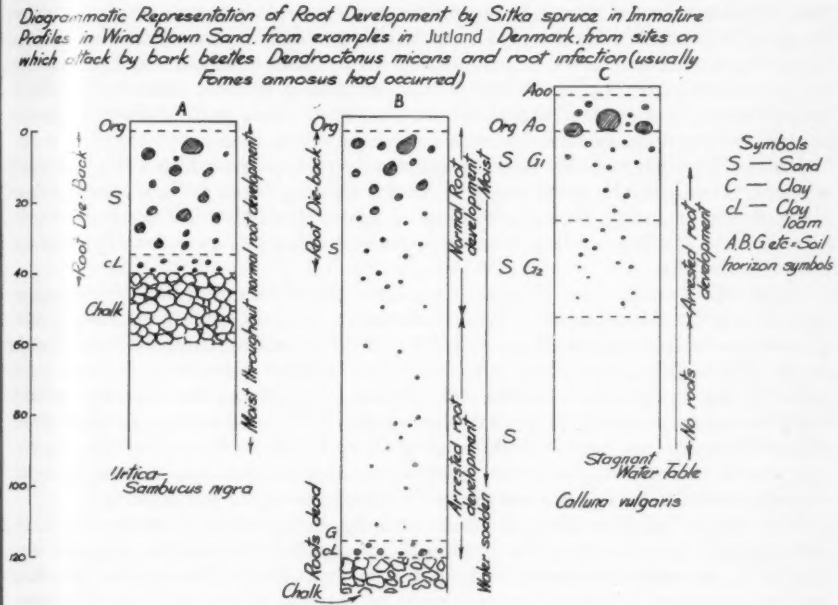


FIG. 7.

physical structure of the sand, which tends towards compaction and low porosity, and thirdly, in the compact, more or less consolidated subsoil which is easily saturated, but of low porosity and a poor source of water supply. Cultivation makes no fundamental remedy of the adverse conditions, but usually greatly stimulates early growth. The problem of supply to the more mature canopy remains, however, and in this, is to be found a basic cause of susceptibility to root infecting fungi, such as *F. annosus* or *Armillaria mellea*, or to susceptibility to bark-beetle infestation.

Fig. 7 illustrates profiles seen in the dune country in western Jutland, Denmark. The soil, at least on the surface, consists of blown sand and has the fine, even grained nature, combined with a tendency to low porosity and, at depth, compaction, which is characteristic of such material. Profiles 7A and 7B, which were taken in a 25-year-old plantation of Sitka spruce under attack by *Dendroctonus micans* and in which *Fomes annosus* occurred, illustrate the effect of change in depth of sand on root development: in both these profiles the sand overlay broken chalk rock. The shallow sand was abundantly rooted and roots penetrated abundantly through the fissures of the relatively small pieces of chalk below. The profile was

examined at the end of the cool wet summer of 1954 and both the sand and chalk were moist. Profile 7B shows sand with a depth of a metre (40 inches): this sand was moist at the top but gradually increased in wetness with increasing depth, so that the lower part was sodden with water; the chalk below was also dripping with water. This provides a striking example of the slow rate at which fine-grained soils which are not clays may drain. Root development was normal in the upper 15 inches of sand, so that the usual development of fine feeding roots occurred; but the roots in the deeper sand exhibited arrested development and had remained in the condition seen in well-aerated soil only during the initial period of root extension, the subsequent development of finely branched roots never being achieved. The whole of the roots in the sodden lower sand and in the chalk below were dead: root die-back had also occurred in the surface sand. This phenomenon of arrested root development can be seen in many fine-grained sand soils, and it is also common in other soils which are subject to considerable periods of saturation. Fine-grained sands such as those referred to, also tend as mature soils to achieve such a condition of consolidation in the lower layers that occupation by fine roots is impossible except along lines of structural weakness; but since these pseudo-fissures provide a means of aeration, normal fine root branching often occurs in them.

Profile 7C illustrates root distribution in a deep, blown sand, in a flat area, with a stagnant water table. Such stagnant conditions may occur within a few yards of a deeply cut, running, drainage ditch, and again, this illustrates the low porosity of this material. The same general type and conditions of root development was shown as in 7B.

Sand soils such as those illustrated are often sufficiently supplied with nutrients to enable Sitka spruce, or other species of conifer, to make quite good early growth providing there is adequate water available. The critical time approaches after the stand is in high canopy, when, with increase in canopy volume, there is a corresponding rise in demand from the soil. Cultivation improves the initially available supplies, and so stimulates growth during the first decades. It may appreciably advance the economic value of the site; but it does not for long avoid the onset of disease, or susceptibility to insect infestation based on debility, because no really fundamental change has been made in the character of the soil material.

The aim in bringing forward these examples, to illustrate, to some extent, the relationship between character of soil and susceptibility to disease, has not been unduly to depress those that practise forestry, or to decry Sitka spruce, which, in its proper sphere, is a useful enough tree, but to draw attention to the limitations for growth which are natural to forest sites and which in the main have to be accepted as part of the burden of management. If a site can only produce poor natural forest, from the standpoint of economic exploitation, it is very unlikely that it will be able to carry fine conifer stands, at least much beyond the first stages of growth, even if some soil amendment and cultivation is carried out. The deficiencies of the root growing space will inevitably ensure that, at the appropriate time in terms of size of tree, disease in one form or another will develop. There has of course been no attempt here to deal with the complexities of the development of such disease in relation either to competitive or pathogenic factors; it has been mainly desired to point to its sheer physical inevitability.

It is thus a matter of importance that one should recognise that the manner of development of a stand is basically determined by the supply character of the soil on which it grows, the effect of other things such as climatic factors, infestations or infections and so on, being appropriately discounted. Thus an attempt to stimulate early growth, for example, by wide spacing or early heavy thinning, will succeed up to the size limit to which a site will permit the trees to grow. An interesting example from Denmark can be taken from the thinning experiment described by Hendriksen (1958) and in which Profile 6A was taken. The trees in

this experiment became subject to infestation by *Dendroctonus micans* after the drought year, 1947: and the treatment most severely affected at first was that which had been subjected to the most heavy thinning and had shown the greatest crown and diameter development. Why, it may be asked, was this so? The answer seems to be that heavy thinning, by stimulating individual growth in size, resulted in the trees reaching the supply limit of the site, at the level of this during a drought year, to a greater degree than those in the less heavily thinned plots, or in that which was not thinned at all. Now it is possible that heavy thinning was as good an economic policy as any other, under the circumstances; that is a matter for appropriate calculation. It is merely desired to point out that limits may be set to the effectiveness of any thinning treatment, especially if this is thought of as producing a quickly grown, relatively even-sized crop. Doubtless within the limits of the capacity of the soil, development towards this end usually may be obtained; but the nature of the site will itself decide the degree to which such treatment is feasible as a permanent policy, or will in any particular case actually succeed.

Consideration will show that if the capacity of the soil to supply the necessities for healthy root development and action is a basic factor governing the development of forest, then on many sites local changes in such capacity must mean that there will be significant local changes in growth and development. For example, on the site from which Profile 5B was taken, the depth of permanently rootable soil varies from about three inches to at least fifteen inches. Moreover, some of the deeper soils occur on slight knolls subject to good surface drainage, while others occur on slopes down which, for appreciable periods, there is some natural subsoil irrigation. Such variations within a relatively small area ensure the development of a mosaic or pattern of growth which, as the trees grow larger, and so more susceptible to the various site deficiencies, will ensure that local variations in condition of stand develop. It will be noticed that the causes of such variations, taking the best growth as a standard, are pathogenic, in that they prevent growth taking place which genetically is possible, and which, climatic conditions being what they are, will be attempted. Even when competitive effects have been allowed for, this frustration of attempted growth is still important.

For reasons such as these, consistency in treatment of a stand over any appreciable area may not be possible, even if short rotations are envisaged. Hiley (1959), in his recent work on the raising of fast-grown pine plantations in South Africa, points out that this has been achieved successfully at wide spacings, on soil of good quality in terms of growth, during the short rotation which is necessary to achieve what is desired for utilisation purposes. It is on such high quality soils that consistency in treatment is relatively easy to achieve successfully. On the other hand, the failure of Sitka spruce under attack by *Dendroctonus micans*, at Nystrup, referred to above, provides an example of what may take place if growth stimulation is carried out on a site of good intrinsic fertility, but of rather limited soil supply capacity. I have demonstrated (Day, 1953), using examples from European larch grown in Britain, that very great variations in pattern of growth occur from site to site; and indeed this must be within the knowledge of all foresters of experience. The period of efficient growth is size of tree, whatever the type of treatment, may be relatively short on some sites, so that the maintenance of a complete overhead high canopy, efficient in terms of volume production, becomes impossible over even very moderate periods of time. There have, for example, been sites on which Japanese larch has so fallen in rate of volume increment that it has been heavily thinned and underplanted at thirty years of age with a view to change of crop, in this case to Western Hemlock. The main growth-restricting condition in the cases in mind was provided by shallow, but reasonably fertile soil, which was well drained and overlay either hard rock or pure shale gravel; but obviously there are many other possibilities in regard to soil conditions.

Examples of this type can be obtained from any of the trees grown for economic purposes: it is merely a matter of finding the right type of site with a stand in which the trees have reached an appropriate size in development. Forestry must, however, at least in this country, often be carried out on sites in which the period of even moderately rapid growth of dominants is comparatively short. Response in growth to wide spacing will therefore also be short, and attention will be compelled to what is the type of stand which is efficient from the standpoint of production under such conditions. This is an ancient problem in European forestry and, at least in part, has been met by the development of more or less irregular forests of complex canopy structure. The degree to which such complexity is permitted, or taken advantage of, is to no small extent economically determined; but it may be pointed out that biologically two tendencies, at least, are shown in natural development. So long as soil supply is above canopy demand, there will be a natural development of a complex canopy providing there is light enough for the growth of understories: under these conditions the maximum degree of stability and health in the forest tends to occur. However, it is true also that if soil supply falls below canopy demand, a complex canopy tends also to develop. Under these conditions the dominants, as the trees making the highest demand, develop signs of debility, tend to fail and, because of this, show a reduced demand from the soil. When this condition has been reached, a surplus of supply occurs during periods of greater abundance, usually the more moist and less hot times, and the development of an understory becomes possible. The development of a complex canopy under these circumstances always implies the presence of debility in some degree, if not of obvious disease, in the larger trees. Further, since the high canopy will be either incomplete, or, if complete, relatively light in density, the growth of an understory of some sort cannot be prevented. These conditions, in which the development of a complex canopy is compelled through the action of a soil supply which is deficient in relation to the climatic possibility, probably occur widespread in our plantations and often take effective action at a relatively early age. The silvicultural and economic consequences to which they lead may not be avoided and need seriously to be considered.

The suggestion from considerations such as those put forward is that, in developing management, foresters need particularly to attempt to assess what is the reality of the productive processes which, in terms of growth, they will be compelled to accept and make do with. No stereotyped and mechanical viewpoint is efficiently possible. Economic efficiency, however desirable, can only be achieved, on one side, through a proper recognition of the biological productive processes. The very variability of these, demands flexibility of outlook in silvicultural development and technique. The development of such flexibility depends partly on economic possibility; but even more on the recognition of effective biological situations, and it is with some aspects of these that I have tried to deal.

References

Bonnevie-Svendsen, C. & Gjems, O. (1957): 'Amount and chemical composition of the litter from larch, beech, Norway spruce and Scots pine stands and its effect on the soil', *Medd. Norske Skogsfors.* **14** (48), 111–75.

Day, W. R. (1953): *The Character of the Soil and its Relation to Root Infections and Stem Decays* (14 pp.), Ontario Research Foundation, Toronto, Canada. Mimeographed.

—— (1954): 'Drought Crack of Conifers', *Forestry Comm. Forest Record*, No. 26 (London, 40 pp.).

—— (1959): 'Observations on eucalypts in Cyprus: I. The character of gum veins and anatomical indications for their origin', *Empire Forestry Rev.* **38** (1), 35–44, 95.

Hendriksen, H. A. (1958): 'The increment and health condition of Sitka spruce in Denmark', *Det Forstl. Forsøgsv. Danmark*, **XXIV**, 1, 1–371.

Hiley, W. E. (1959): *Conifers, South African Methods of Cultivation* (London, 123 pp.).

Møller, C. M. (1945): 'Untersuchunger über Laubmenge, Stoffverlust und Stoffproduktion des Waldes', *Det Forstl. Forsøgsv. Danmark*, **XVII**, 1–287.

SCIENTIFIC FILMS

I. Thirteenth Congress of the International Scientific Film Association

This congress was attended by more than 170 delegates and observers from twenty countries. The largest delegation from abroad was one of twenty-nine from the U.S.S.R., whilst the British contingent numbered sixty-six.

Some 200 films were screened during the Congress, the majority in simultaneous sessions of the popular science, education and research film sections, and some in public performances of popular science films at Oxford Town Hall, and the National Film Theatre in London.

The practice (begun last year at the Moscow Congress) of presenting awards for popular science films as an incentive to producers was continued. In addition, the British organisers presented a special award for the best foreign film shown at the Congress. This went to the Czech film, 'Drops and Bubbles', a beautiful colour study of bubble formation and surface tension.

Diplomas of Merit were awarded to the following films: 'On Shining Traces' (Czechoslovakia), a popular account of aspects of research into electrical discharges; 'Life of Termites' (France), a study of African termites; 'Animals in Winter' (German Democratic Republic), a teaching film showing the hibernation processes of small mammals, reptiles and amphibians; 'The Island of Mongooses' (Hungary); 'The Synchrotron' (Italy), a popular account which relied on clever animation superimposed on location shots of equipment; 'The Water-Striders' (Poland), a beautifully-made short teaching film on the stimuli which enable 'water boatmen' to locate their prey; 'Schlieren' (Great Britain), the Shell film on the schlieren technique of cinematography, which won the B.A. award at Harrogate; and 'Jungle Trail' (U.S.S.R.), a long nature film shot in the jungles of China.

Special commendations were awarded to 'Alcoholism' (Austria)—'for its film treatment of experimental material'; 'Motion and Time' (Czechoslovakia)—'for its treatment of a difficult subject' (a popular exposition of Einstein's theory of relativity); and 'The Mason Wasp' (France)—'for the quality of its cinematography'.

It is impossible to make direct comparison between films of widely different subjects and methods of approach. In the case of popular science films the issue is further complicated by the different interpretations of this term. In Great Britain and the United States it is generally accepted that a popular science film is one which is designed to present to a lay audience an account of some aspect of a fairly-well defined field of scientific enquiry. Such an interpretation would also apply to many other Western European countries, although there are those who ignore it and enter sales promotion and sales training films. Thus the films on Fiat cars and the sales training film from Renault had obviously no place in a Conference of this kind, although they were included in the national entries. On the other hand there are others who interpret science as knowledge and the Eastern Europeans and Russians and some of the Latin American countries present subjects such as history, art and technology as popular science. There is a tendency, too, for national entries to have a bias in a particular direction—a reflection on the nature of the local selection and also on the sort of material in which the individual delegates are themselves interested. At this Congress, therefore, one could find popular films on subjects as diverse as the function of the labyrinths in space flight; small arms manufacture; a village preserved as a museum; pre-history; prejudice against injections for polio; prehistoric art in the Sahara; astronomy; micro-biology; oriental writing; and sturgeon fishing.

Research material included many medical subjects, metallurgy, biology and physics. Education films ranged from a simple account of the starting system of a tractor (part of a long series made in the Soviet Union for tractor operatives) to field astronomy—the first part of a series of animated films for Army training in Great Britain.

Brief details of nearly all the film entries at the Congress are to be found in the August 1959 issue of *Scientific Film Review*, obtainable from the Scientific Film Association, 3 Belgrave Square, S.W.1.

II. First Conference of the National Committee for High-Speed Photography, Queen Mary College, September 18, 1959

In order to develop nationally the work initiated by international conferences on high-speed cinematography, which have been held at two-yearly intervals in Washington, Paris, London and Cologne, a National Committee on High-Speed Photography was recently formed.

This Committee, under the chairmanship of Dr. W. Deryck Chesterman of the Institute of Physics, is widely representative and held its first conference on the use of high-speed photography in industry. It is intended to follow this with other conferences, possibly on subjects such as flow visualisation in liquids and gases and recent developments in light source design for short flashes.

The Committee would welcome suggestions for other appropriate subjects and also for centres for meetings, as it is not intended to confine them all to London. Suggestions should be sent to Dr. R. F. Saxe, Queen Mary College, Mile End Road, London, E.1.

At this conference nearly 200 delegates (about double the number anticipated) were able to see examples of the use of high-speed cinematography for research in the electrical industry, textile industry, the motor industry, the atomic energy industry and at the National Physical Laboratory.

Papers presented included one by J. C. Needham, of the Electrical Research Association, showing the use of still and cinematography techniques for studying electric arcs and the movements of metal during welding.

R. A. Barker, of the British Rayon Research Laboratories, showed film examples of research into yarn winding and twisting, the use of automatic shuttles, the movement of weft in weaving and the behaviour of knitting and sewing machines.

R. J. North, of the National Physical Laboratory, gave examples of the use of the film in aerodynamic research. This is by no means confined to aeronautics and examples he showed included an investigation into the vibration of boiler tubes operating at high temperatures. Other studies included schlieren photography of phenomena such as aileron buzz and the formation of shock waves around nose cones, glass surfaces and flat surfaces.

J. G. Hempson, of Ricardo, presented some studies at 16,000 f.p.s. of combustion in a diesel engine. These were achieved by replacing the top of the cylinder with a mica plate and photographing the combustion as the fuel was injected.

Finally, P. G. Gibbs, of the United Kingdom Weapons Establishment, Aldermaston, showed some film records of fracture processes when detonators were placed on the edges or flat surfaces of glass sheets.

SEISMOLOGICAL INVESTIGATIONS 1959

SIXTY-FOURTH (1959) ANNUAL REPORT of the COMMITTEE on Seismological Investigations. (Dr. R. STONELEY, F.R.S., *Chairman*, Mr. E. TILLOTSON, *Secretary*, Mr. E. F. BAXTER, Miss E. F. BELLAMY, Prof. P. G. H. BOSWELL, O.B.E., F.R.S., Mr. B. C. BROWNE, Sir E. C. BULLARD, F.R.S., Dr. K. F. CHACKETT, Dr. G. E. R. DEACON, C.B.E., F.R.S., Dr. A. T. J. DOLLAR, Dr. A. E. M. GEDDES, O.B.E., Prof. G. R. GOLDSBROUGH, C.B.E., F.R.S., Dr. M. N. HILL, Mr. J. S. HUGHES, Sir H. JEFFREYS, F.R.S., Dr. E. R. LAPWOOD, Rev. C. REY, S.J., Sir FRANK SMITH, G.C.B., G.B.E., F.R.S., Dr. G. D. ROBINSON, Mr. H. V. SHAW, and Dr. K. H. STEWART.)

THE GRAY-MILNE FUND

As intimated in last year's report, the balance of the Crombie Bequest, amounting to £500, has now been paid over to the Crombie Laboratory, University of Cambridge, for the purchase of scientific equipment. The sum of £400 is still invested in 2½ per cent Defence Bonds, and it is intended to invest a further part of the accumulated balance. The outstanding cheque for £2 17*s.* 7*d.* mentioned in last year's accounts is shown as a payment in this year's account.

Receipts

	£	*s.*	*d.*
Balance, June 29, 1958 . . .	789	3	6
Trust Income	80	14	10
Interest from Defence Bonds . .	10	0	0
Premium on conversion of Defence Bonds	7	3	0
	887	1	4

Payments

	£	*s.*	*d.*
Secretarial Expenses	2	17	7
Balance at Bank, July 31, 1959 . .	884	3	9
	887	1	4

INSTRUMENTS

There has been no change in the location of the instruments belonging to the Committee during the past year. The instruments are located as follows:

Milne-Shaw Seismographs

No. 1. Science Museum, South Kensington.
,, 3. Edinburgh.
,, 4. Downe, Kent (in storage).
,, 6. Hermanus, South Africa.
,, 27. Perth, Western Australia.
,, 63. Suva, Fiji.

The Jagger Shock Recorder is at Fort Augustus, Scotland.

Application has been made by the Mines and Geological Department of KENYA for the loan of the Milne-Shaw Seismograph (No. 4) at present in store at DOWN

HOUSE. This request has been acceded to, and arrangements are being made for the transfer.

INTERNATIONAL SEISMOLOGICAL SUMMARY

by J. S. Hughes, M.A.

The work on the Seismological Summary at the time of writing this note (July 1959) is occupied with the year 1951. The second part of this year should be issued shortly. The third quarter is partly in the hands of the printer and the remainder available to them when required. Work of preparation of November is in hand. The staff employed consists of Mr. Wavish as chief assistant, with Mrs. Sanders in charge of the clerical and secretarial side. We also have now Mr. H. Gulley and Mr. G. Muir on the staff and part-time help from Mr. H. Strickland and Mr. J. Biddle, as mentioned in the last report.

The Seismological Summary has now grown to such great proportions that it has been found necessary to take steps to reduce the quantity of printing involved. The number of pages in the last three years 1948, 1949, 1950 were respectively 710, 800 and 1081 with no evidence that any reduction in the figures for successive years will take place unless a change of plan is adopted. Starting with 1952, printing of the Summary will be restricted to that portion of the data which are at present included in the tabular parts. This means omitting at any rate for the present the additional readings to determined earthquakes, the undetermined shocks and the readings not referred to specified shocks hitherto recorded under their day and hour. It is thought that with the large sequence of the Summary in its complete form and with the increase in the data now coming in, the additional readings can be dispensed with. This will not affect the number of stations recorded in the tabular part but numerous reflected waves and refracted waves will not be included.

SEISMOLOGY AT KEW OBSERVATORY, 1958–59

by Dr. K. H. Stewart, Superintendent

The continuous records of the Galitzin three-component and short-period vertical seismographs were maintained and the routine seismological bulletins were printed and issued monthly. In all, the bulletins listed 580 earthquakes, giving provisional epicentres for 120 and 'magnitudes' for 164 of them. Copies of Kew seismograms as well as other data, specially extracted from original records, were supplied, on request, to several overseas Observatories and Institutes. At home many enquiries were answered; the information required mostly related to the effects of seismological activity on engineering and to the seismicity of different regions of the earth.

NATIONAL INSTITUTE OF OCEANOGRAPHY

Director: Dr. G. E. R. Deacon, C.B.E., F.R.S.

Three of the electronic feedback seismographs described by M. J. Tucker (*J. Sci. Instr.*, **35**, 167, 1958) are being used. They are accommodated in a brick-lined pit in the lawn and connected by cable to the recorders in the building. They have a high magnification, up to 18,000, and a flat response from 1 to 10 seconds period. Apparatus for measuring root mean square amplitude and the correlation coefficients between the horizontal and vertical components (H. M. Iyer and B. J. E. Hinde, *Nature*, **183**, 1558, 1959) has been installed for computing the direction of propagation. The effects of North Atlantic storms will be studied throughout the winter by Mr. B. E. J. Hinde in collaboration with Mr. Iyer, who has returned to India.

THE DEPARTMENT OF GEODESY AND GEOPHYSICS, CAMBRIDGE UNIVERSITY

Head of the Department: Mr. B. C. Browne

Report by Dr. M. N. Hill.

Throughout the year the Benioff short-period instruments have been in operation. Full details of earthquakes recorded will be issued within the next month.

Progress with the design of long-period seismographs has been delayed but will start again shortly.

Dr. N. A. Routledge has left the Department and his place has been taken by Mr. F. Gray from Imperial College.

JERSEY REPORT

by The Rev. C. Rey, S.J.

January 2nd 1959.

An earth tremor was felt in Jersey, and recorded on the local seismograph.

H: 05 h. 19 m. 45 s. U.T.
Jersey: iPn 05.20.16·5
iP* 05.20.20
iPg 05.20.25
iSn 05.20.41·5

The style went off the record, and off its bearings.

Felt locally force IV. No damages.

Determination of focus: South of Penmarch Point, Finistere, France.

Every information has been forwarded to Dr. Dollar, for the British Earthquake Inquiry Office.

A violent surface vibration was felt in Jersey about 09 h. 08 m. on July 30, 1959. Though it seems that the movement was more pronounced than on January 2, no damage was reported. The seimograph recorded a slight vibration as follows.

e 09.08.16·5 U.T.
e 09.08.24·5
e 09.08.27
(eL) ?09.08.32

The record does not show any violent impulse, and gives no characteristic type of seismic waves, and confirms the reports almost universal locally of a loud explosion, without any rumbling noise. A few reports of a distant explosion at the same time came from Guernsey. To my mind this was not an earthquake.

A similar report came from Guernsey on August 5 of a tremor, but this seems to be of the same origin. No record of it on the instrument. Approximate time: 09 h. 12 m. U.T.

REPORT FROM SIR M. MacDONALD & PARTNERS

Chartered Civil Engineers

Earthquake at Comrie, October 5, 1958

The shock was experienced at about 9.15 p.m. on October 5, and was reported in the local press as well as being noticed by our staff on the site.

EARTHQUAKE AT COMRIE, JULY 17, 1959

An earthquake of a few seconds' duration only occurred in the Comrie district at about 6.45 a.m. on July 17. Some local residents have said they were conscious of a

tremor and almost everyone heard the loud report which accompanied the 'quake. This sounded more like extensive surface blasting than a subterranean disturbance. It may be that the vibration preceded the noise and would consequently be unnoticed by the vast majority, who were sleeping. The 'quake was felt at St. Fillans and Invergeldie also and, to a much lesser extent, in Crieff. Some observers put the disturbance as being more violent than the one which occurred last October, but many are undecided.

NOTES

1. Publications:

(i) G. Lees: 'The East Midlands Earthquakes of February 11 and 12, 1957', *East Midlands Geographer*, No. 7, June 1957, pp. 52, 53.

(ii) G. Lees: 'An investigation into the effects of the East Midlands Earthquake of Febtuary 11, 1957, on vibration—sensitive Relays at local power stations', *East Midlands Geographer*, December, 1958, pp. 41–5.

The *East Midlands Geographer* is published at Nottingham University. Mr. G. Lees is Lecturer in Geology at the Derby and District College of Technology.

2. Prof. Sir Harold Jeffreys, F.R.S., is at present on a world tour, visiting seismologists and seismological stations. We wish him a good journey and safe return, and by him send greetings to our friends and colleagues overseas.

3. The European Seismological Commission will meet at Alicante, Spain, from October 26–31, 1959.

NERAL TREASURER'S STATEMENT AND ACCOUNT, 1958–59

The General Income and Expenditure Account shows a balance of income for the year of £7,888 17*s.* 3*d.* This relatively large balance is due to the fact that a number of the new activities, which will in future absorb the full income available, are still in the process of development. The income for general purposes has varied within normal limits under most headings. In addition, the sum of £23,501 was received in donations, after deduction of Income Tax, besides which £2,109 was recovered in respect of Income Tax on gifts under covenant for the previous year.

In the case of gifts by single payment or by instalments over less than seven years, a proportion amounting to £3,694 has been appropriated to later years, leaving the sum of £19,807 shown as donations for the year. This figure includes a gift of £5,000 given specially for the Young People's programme. A similar sum has been promised for 1959–60.

The Association may expect to receive in donations £54,000 (from ten companies which responded to the Association's appeal in 1957) and £102,000 (from 69 other firms approached a year later), besides a special gift of £10,000 given in two instalments. These additional funds transform the Association's opportunities for service—hitherto limited by an annual budget not exceeding about £11,000; and their effect will be roughly to treble the Association's income for general purposes over a period of five to six years.

During the year which has now elapsed the Association has in fact extended its activities on a scale not previously found possible. The range of new projects undertaken or contemplated is described in full in the Report of the Council to the General Committee.

The accounts show how special funds, including those provided by the Carnegie United Kingdom Trust for the Directory of Natural History Societies and by the Leverhulme Trust for the Study Group on the Education of the Graduate Scientist have been employed. The work of the Study Group on the Metric System, under the chairmanship of Sir Hugh Beaver, K.B.E., Managing Director of Arthur Guinness, Son & Co. Ltd., has been financed by a few large industrial concerns. The Science and Industry Committee, hitherto financed by the Board of Trade, the Department of Scientific and Industrial Research and the Nuffield Foundation, has completed its work and is about to be wound up.

A great effort will have to be made during the next five years to enlarge the Association's influence and to establish its financial position. To the extent that membership subscriptions are related to attendance at the Annual Meeting, growth is limited by the capacity of meeting places. Subscriptions to the Association's Journal are not limited in this way, and a number of changes in the Journal are contemplated which, it is hoped, will lead to a greatly enlarged circulation. Thought is also being given to the membership structure as a whole: it is hoped that an increase in the number of Companies and Institutions in touch with the Association through corporate membership will be achieved, and that through the Area Committees now being established, many people will be introduced to the work of the Association and encouraged to become continuing members.

The Association's staff has been augmented to meet its new responsibilities: more suitable office accommodation has been secured and the Development Fund raised in 1947 has been drawn upon to equip it.

RENNELL

Balance Sheet, 31st March, 1959

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison)

LIABILITIES

	£ s. d.	£ s. d.
GENERAL PURPOSES :—		
Sundry Creditors	2,385 3 5	
Amounts received in advance for publications	317 9 3	
Membership and Associateship subscriptions in advance	153 4 0	
		2,855 16 8
Accumulated Fund		39,592 12 11
Life Membership Fund		
As at April 1, 1958	9,134 15 4	
Add Subscriptions received during year	388 10 0	
		9,523 5 4
General Revenue Reserve Account		
As at April 1, 1958	3,797 18 0	
Add Transfer from Income and Expenditure Account	6,988 17 3	
		10,786 15 3
Donations reserved under 7-year plan		3,694 5 8
Annual Meeting Fund		
Transfer from Income and Expenditure Account		750 0 0
Reserve for Redecorations		150 0 0
Employees' Benefit Fund : Transfer from Income and Expenditure Account	1,000 0 0	
Add Interest on Investment	12 15 7	
		1,012 15 7
[*55,875 13 1*]		68,365 11 5
Development Fund (1947)		
As at April 1, 1958	6,339 19 6	
Less Loss on realisation of Stock	525 15 7	
Less Excess of Expenditure over Income for the year	2,201 13 11	
	2,727 9 6	
[*6,339 19 6*]		3,612 10 0
[*62,215 12 7*]		£71,978 1 5
SPECIAL PURPOSES :—		
Caird Fund		
Capital	9,511 9 11	
Income and Expenditure Account balance as at April 1, 1958	972 13 3	
Add Excess of Income over Expenditure for the year	63 16 4	
	1,036 9 7	
[*10,484 3 2*]		10,547 19 6
Bernard Hobson Fund (1933)		
Capital	1,093 2 6	
Income and Expenditure Account balance as at April 1, 1958	427 14 2	
Add Excess of Income over Expenditure for the year	38 12 4	
	466 6 6	
[*1,520 16 8*]		1,559 9 0
Leicester and Leicestershire Fund (1933)		
Capital	1,000 0 0	
Income and Expenditure Account balance as at April 1, 1958	213 8 7	
Add Excess of Income over Expenditure for the year	36 19 1	
	250 7 8	
[*1,213 8 7*]		1,250 7 8
Radford Mather Lecture Fund (1936)		
Capital	242 18 0	
Income and Expenditure Account balance as at April 1, 1958	60 6 4	
Add Excess of Income over Expenditure for the year	7 6 8	
	67 13 0	
[*303 4 4*]		310 11 0
[*13,521 12 9*] Carried forward		13,668 7 2

ASSETS

	£ s. d.	£ s. d.
GENERAL PURPOSES :—		
Investments as scheduled with Income and Expenditure Account, No. 1	57,974 18 2	
Sundry Debtors	358 15 4	
Cash and stamps in hand	24 2 0	
Cash at bank—		
On deposit 9,043 8 5		
On current account 768 18 4		
On imprest account 195 9 2		
	10,007 15 11	
		68,365
[*55,875 13 1*]		68,365
Development Fund (1947)		
Investments (see Income and Expenditure Account, No. 2)	3,358 1 5	
Cash at bank	254 8 7	
[*6,339 19 6*]		3,612
[*62,215 12 7*]		£71,978
SPECIAL PURPOSES :—		
Caird Fund		
Investments (see Income and Expenditure Account, No. 3)	10,311 9 11	
Cash at bank	236 9 7	
[*10,484 3 2*]		10,547
Bernard Hobson Fund (1933)		
Investments (see Income and Expenditure Account, No. 4)	1,393 2 6	
Cash at bank	166 6 6	
[*1,520 16 8*]		1,559
Leicester and Leicestershire Fund (1933)		
Investments (see Income and Expenditure Account, No. 5)	1,150 0 0	
Cash at bank	100 7 8	
[*1,213 8 7*]		1,250
Radford Mather Lecture Fund (1936)		
Investments (see Income and Expenditure Account, No. 6)	242 18 0	
Cash at bank	67 13 0	
[*303 4 4*]		310
[*13,521 12 9*] Carried forward		13,668

Balance Sheet, 31st March, 1959 (*continued*)

(*Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.*)

LIABILITIES (*continued*)	£	s.	d.	ASSETS (*continued*)	£	s.	d.
[*1 12 9*] Brought forward . .	13,668	7	2	[*13,521 12 9*] Brought forward . .	13,668	7	2
Arthur Haydock Bequest (1945)				*Arthur Haydock Bequest* (1945)			
Capital 2,215 12 0				Investments (see Income and Expenditure Account, No. 7) . 2,865 12 0			
Income and Expenditure Account balance as at April 1, 1958 . 789 15 1				Cash at bank 130 3 11			
Add Excess of Expenditure over Income for the year . . . 9 11 2							
780 3 11							
[*3,005 7 1*]	2,995	15	11	[*3,005 7 1*]	2,995	15	11
Directory of Natural History Societies				*Directory of Natural History Societies*			
Balance as at April 1, 1958 . . 10 10 1				Cash at bank (see Income and Expenditure Account, No. 8) . 106 7 7			
Add Excess of Income over Expenditure for the year . . 132 14 11				Sundry Debtors 36 17 5			
[*10 10 1*]	143	5	0	[*10 10 1*]	143	5	0
Science and Industry Committee				*Science and Industry Committee*			
Balance as at April 1, 1958 . . 32 9 7				Cash at bank 32 9 7			
Department of Scientific and Industrial Research grants . . 515 12 6							
Nuffield Foundation grant . . . 825 0 0							
1,340 12 6							
1,373 2 1							
Less Amounts transferred to the Committee 1,340 12 6							
[*32 9 7*]	32	9	7	[*32 9 7*]	32	9	7
Leverhulme Study Group				*Leverhulme Study Group*			
Amount received from the Leverhulme Trust 1,500 0 0				Cash at bank 43 16 6			
Less Expenditure chargeable to the Trust (see Income and Expenditure Account No. 9) . . 1,446 11 9				Cash in hand 9 11 9			
[- - -]	53	8	3	[- - -]	53	8	3
[*16,569 19 6*]	£16,893	5	11	[*16,569 19 6*]	£16,893	5	11

We have examined the foregoing Account with the Books and Vouchers and certify the same to be correct. We have also verified the balance at the Bankers and the Investments.

Approved:
HENRY S. MAULE
A. HARDEN
Auditors.

W. B. KEEN & CO., *Chartered Accountants*,
Finsbury Circus House, Blomfield St., E.C.2

10th June, 1959.

INCOME AND EXPENDITURE ACCOUNTS FOR THE YEAR ENDED 31st MARCH, 1959

No. 1. General Income and Expenditure

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison)

		£	s.	d.
	Investments at cost:			
	£8,264 4s. 4d. Consolidated 2½ per cent. Stock	6,401	3	0
	£1,999 0s. 4d. British Gas 3 per cent. Stock, 1990/95	1,520	14	10
	£18,400 0s. 0d. 3 per cent. Savings Bonds, 1965/75	19,098	11	9
	£52 12s. 7d. 3½ per cent. War Stock (Post Office issue)	54	5	2
	£7,704 6s. 2d. 3½ per cent. War Stock	7,840	0	9
	£6,768 15s. 7d. 3½ per cent. Conversion Stock, 1961 or after	5,726	8	11
	£4,184 18s. 2d. 2½ per cent. Treasury Stock, 1975 or after	4,184	18	2
	£1,400 0s. 0d. 4 per cent. Funding Loan Stock, 1960/90	1,622	0	0
	£981 10s. 0d. 4 per cent. Commonwealth of Australia Stock, 1955/70	1,000	0	0
	£4,897 18s. 11d. 3 per cent. British Transport Stock, 1978/88	3,824	11	2
	£100 0s. 0d. 3½ per cent. Defence Bonds	100	0	0
	£3,386 18s. 6d. Conversion 5½ per cent. Stock, 1974	3,378	0	0
	£987 12s. 1d. Conversion 4½ per cent. Stock, 1962 (Employees' Benefit Fund)	1,000	0	0
	£2,745 19s. 0d. London County 2¾ per cent. Consolidated Stock, 1960/70	2,224	4	5
[*Value of stocks at 31/3/58, £35,021*]	(Value at 31/3/59 £43,633			
[*51,372 13 9*]		£57,974	18	2

EXPENDITURE

	£	s.	d.	£	s.	d.
Salaries, wages, pensions and National Insurance				10,545	8	2
Employees' Benefit Fund				1,000	0	0
Temporary clerical assistance and fees				379	1	6
Lift at Burlington House				19	1	0
Office service charge				146	11	11
Heat, Lighting and Power				121	18	2
Hire and equipment of meeting rooms, etc.				55	5	6
Printing, etc.—						
"The Advancement of Science"	3,005	19	4			
Preliminary Programme, 1958	689	13	3			
Programme, 1958	854	13	3			
Miscellaneous	606	15	6			
				5,157	1	4
Stationery				1,383	14	7
Reference books, press cuttings, etc.				85	7	4
Badges				76	3	0
Postages				955	10	7
Stamp duty on covenants				176	1	4
Carriage				77	15	8
Maintenance of machines				41	12	2
Telephone				188	12	10
Insurances				14	3	11
Travelling expenses				1,480	5	10
Hospitality				425	2	11
Audit, etc., for 1957-58				131	5	0
Exhibitioners	300	15	4			
Less Contribution by Liverpool University	88	0	0			
				212	15	4
Panels of Armorial Bearings				14	8	9
Visual aids, including hire of films	169	0	1			
Cost of Cine-projector and accessories	256	17	8			
				425	17	9
Lecture Fees	451	10	0			
Less Contributions received	147	18	9			
				303	11	3
Payments to Area Committees—						
Newcastle upon Tyne	362	0	9			
Teesside	100	0	0			
Cornwall	100	0	0			
Durham	231	14	11			
				793	15	8
Subscription to Parliamentary and Scientific Committee				15	15	0
Subscription to International Union for the Conservation of Nature and Natural Resources				5	0	0
Legal advice (see also under Development Fund)				116	18	0
Sundry expenses				134	15	11
[*15,550 13 5*] Carried forward				24,533	0	5

INCOME

	£	s.	d.	£
Membership subscriptions				5,700
Sale of publications:				
"The Advancement of Science"	829	19	3	
Other items	119	0	0	
				948
(For Directory of Natural History Societies see Income and Expenditure Account, No. 8)				
Advertisements in B.A. publications:				
"The Advancement of Science"	583	1	7	
Preliminary Programme, 1958	499	6	5	
Programme, 1958	668	5	0	
				1,750
Income Tax recovered to 31st March, 1958:				
On Interest and Dividends	79	2	8	
„ Donations under covenant	2,109	6	7	
				2,188
Interest on Investments	1,701	3	11	
„ „ bank deposits	179	5	6	
				1,880
Donations received (excluding Income Tax recoverable):—				
Special donation for Young People's Programme	5,000	0	0	
Other donations	18,501	7	2	
Less amount appropriated to later years under 7-year plan	3,694	5	8	
	14,807	1	6	
				19,807
Association of British Science Writers, for secretarial services				70
Charges for administration of special funds				75
[*19,348 11 5*] Carried forward				32,42

No. 1 General Income and Expenditure (*continued*)

EXPENDITURE (*continued*)	£ s. d.	£ s. d.	INCOME *continued*	£ s. d.	£ s. d.
[19,348 11 5] Brought forward		24,533 0 5	*[19,348 11 5]* Brought forward		32,421 17 8
Net being excess of Income over Expenditure for the year, carried down *[1,218 0]*		7,888 17 3			
[19,348 11 5]		£32,421 17 8	*[19,348 11 5]*		£32,421 17 8
Transfer to—					
Reserve for redecorations	150 0 0				
Annual Meeting Fund	750 0 0				
General Revenue Reserve	6,988 17 3				
		7,888 17 3	Balance brought down		7,888 17 3
		£7,888 17 3			£7,888 17 3

No. 2. Development Fund

Appeal for a Development Fund to be used under the direction of the Council, was made at the Annual Meeting at Dundee in 1947. The fund is still open.

(*Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.*)

	£ s. d.	£ s. d.
Investments at cost:		
£3,387 14*s.* 10*d.* Savings 3 per cent. Stock, 1965/75	3,028 7 0	
£292 15*s.* 3*d.* Consolidated 2½ per cent. Stock	200 0 0	
£175 0*s.* 0*d.* 3½ per cent. War Stock	129 14 5	
[Value of stocks at 31/3/58. £4,723] (Value at 31/3/59, £2,845)		
[6,108 1 5]		£3,358 1 5
Cash at bank		£254 8 7

EXPENDITURE	£ s. d.	£ s. d.	INCOME	£ s. d.	£ s. d.
Cost of removal of office, including storage charges	158 3 9		Interest *[190 11 8]*		190 11 8
Solicitors' charges and stamp duty on deed of sub-lease	119 12 6		Balance, being excess of Expenditure over Income for the year *[302 7 6]*		2,201 13 11
Furniture, equipment, etc.	1,946 19 4				
Carpentry and electrical work	148 8 10				
Administration charge	19 1 2				
[492 19 2]		£2,392 5 7	*[492 19 2]*		£2,392 5 7

No. 3. Caird Fund

Unconditional gift of Sir James Caird, in 1912, administered by the Council in accordance with recommendations adopted by the General Committee in 1913.

(*Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.*)

	£ s. d.	£ s. d.
Investments at cost:		
£2,904 11*s.* 8*d.* British Gas 3 per cent. Stock, 1990/95	2,209 13 0	
£2,716 16*s.* 6*d.* 3½ per cent. War Stock	2,516 15 5	
£4,282 18*s.* 9*d.* 3 per cent. British Transport Stock, 1978/88	4,785 1 6	
£585 10*s.* 6*d.* Consolidated 2½ per cent. Stock	400 0 0	
£400 Borough of Watford 5¾ per cent. Loan	400 0 0	
[Value of stocks at 31/3/58, £7,008] (Value at 31/3/59, £7,397)		
[10,311 9 11]		£10,311 9 11
Cash at bank		£236 9 7

EXPENDITURE	£ s. d.	£ s. d.	INCOME	£ s. d.	£ s. d.
Cost of tables at Biological Stations 1959 :—			Interest		311 5 2
Marden Zoological Station	100 0 0		Income Tax recovered		59 13 0
Freshwater Biological Association, Windermere	50 0 0		*[332 3 3]*		370 18 2
Marine Biological Association, Plymouth	50 0 0		Balance, being excess of Expenditure over Income for the year *[11 1 1]*		– – –
		200 0 0			
Grants paid to research committees :—					
Britannia Archaeologica	10 0 0				
Society of Japan	50 0 0				
Experiment Field Systems	10 0 0				
		70 0 0			
Administration Charges		37 1 10			
		307 1 10			
Net, being excess of Income over Expenditure for the year		63 16 4			
[343 4 4]		£370 18 2	*[343 4 4]*		£370 18 2
Grants authorised, not yet drawn :—					
Experiment Field Systems	170 0 0				
[– – –]		£170 0 0			

No. 4. Bernard Hobson Fund

The bequest of Mr. Bernard Hobson, 1933; the income to be applied to the promotion of geological research; administered by the Council.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

	£ s. d.	£ s. d.
Investments at cost:		
£50 0s. 0d. 4 per cent. Victory Bonds		55 10 5
£601 9s. 0d. 2½ per cent. Treasury Stock, 1975 or after		601 9 0
£416 0s. 11d. 3½ per cent. War Stock		436 3 1
£178 16s. 4d. Consolidated 2½ per cent. Stock		150 0 0
£150 Borough of Watford 5½ per cent. Loan		150 0 0
[*Value of stocks at 31/3/58,* £842] (Value at 31/3/59, £870)		
[*1,393 2 6*]		£1,393 2 6
Cash at bank		£166 6 6

EXPENDITURE	£ s. d.	[*]	INCOME	£
Administration charge	4 5 10	[*3 17 3*]	Interest	41
Balance, being excess of Income over Expenditure for the year	38 12 4	[*34 15 2*]	Income Tax recovered	1
	£42 18 2	[*38 12 5*]		£42

No. 5. Leicester and Leicestershire Fund, 1933

The unexpended balance of the local fund for the Leicester Meeting in 1933, presented to the Association, the interest to be applied in assisting by scholarships or otherwise students working for the advancement of science; administered by the Council.

(Figures in italic type and square brackets, to the left of column, are those of the preceding year's accounts, inserted for comparison.)

	£ s. d.	£ s. d.
Investments at cost:		
£487 2s. 11d. 3½ per cent. Conversion Stock		500 0 0
£490 5s. 11d. 3½ per cent. War Stock		500 0 0
£150 Borough of Watford 5½ per cent. Loan		150 0 0
[*Value of stocks at 31/3/58,* £783] (Value at 31/3/59, £805)		
[*1,150 0 0*]		£1,150 0 0
Cash at bank		100 7 8

EXPENDITURE	£ s. d.	[*]	INCOME	£
Grants	— — —	[*67 0 0*]	Interest	36
Administration charge	4 2 1	[*3 13 6*]	Income Tax recovered	1
Balance, being excess of Income over Expenditure for the year	36 19 1	[— — —]	Balance, being excess of Expenditure over Income for the year	-
	£41 1 2	[*70 13 6*]		£41

No. 6. Radford Mather Lecture Fund

A gift of £250 received from Mr. G. Radford Mather in 1936 to establish a Fund, the income therefrom to be devoted to meeting the expense of triennial Lectures on Recent Advances in Science and their relation to the Welfare of the Community.

(Figures in italic type and square brackets, to the left of columns, are those of the preceding year's account, inserted for comparison.)

	£ s. d.	£ s. d.
Investment at cost:		
£271 14s. 6d. Savings 3 per cent. Stock, 1965/75		242 18 0
[*Value of stock at 31/3/58,* £193] (Value at 31/3/59 £207)		
[*242 18 0*]		£242 18 0
Cash at bank		£67 13 0

EXPENDITURE	£ s. d.	[*]	INCOME	£
Administration charge	16 4	[*— 16 4*]	Interest	8
Balance, being excess of Income over Expenditure for the year	7 6 8	[*7 6 8*]		
	£8 3 0	[*8 3 0*]		£8

No. 7. Arthur Haydock Bequest

quest received in 1945 " for the purpose of original investigation of problems relating to either or both of Geology or Botany as may be determined by the governing body of the British Association."

(Figures in italic type and square brackets, to the left of column, are those of the preceding year's account, inserted for comparison.)

		£	s.	d.
Investments at cost:				
£2,090 4s. 0d. 3½ per cent. Conversion Stock		2,215	12	0
£362 6s. 3d. Consolidated 2½ per cent. Stock		250	0	0
£400 Borough of Watford 5½ per cent. Loan		400	0	0
[*Value of stocks at 31/3/58,* £1,915]	(Value at 31/3/59, £1,978)			
[*2,865 12 0*]		£2,865	12	0
Cash at bank		£130	3	11

EXPENDITURE	£	s.	d.	INCOME	£	s.	d.
e to Suffolk Naturalists' Society, for Research Redgrave Fen	100	0	0	Interest [*89 0 11*]	95	8	10
nistration charge	10	1	0	Income Tax recovered	5	1	0
1 11]					100	9	10
ce, being excess of Income over Expenditure the year	–	–	–	Balance, being excess of Expenditure over Income for the year [– – –]	9	11	2
9 0]							
£4 *0 11*]	£110	1	0	[*89 0 11*]	£110	1	0

No. 8. Directory of Natural History Societies

EXPENDITURE	£	s.	d.	INCOME	£	s.	d.
and National Insurance	497	11	4	Cash received from Carnegie United Kingdom Trust	1,450	0	0
orary clerical assistance	8	7	6	Sales of Directory	126	8	9
nery	7	8	4				
e, etc.	11	8	11				
hone	5	1	1				
ng, etc.	912	19	4				
		16	6				
9 11]	1,443	13	10				
ce, being excess of Income over Expenditure the year	132	14	11				
0 1]							
0 0]	£1,576	8	9	[*550 0 0*]	£1,576	8	9

No. 9. Leverhulme Study Group on Education of the Graduate Scientist in School and University

EXPENDITURE	£	s.	d.	INCOME	£	s.	d.
s, National Insurance and cost of tempo- help	1,334	0	1	Cash received from the Leverhulme Trust Fund	1,500	0	0
lling expenses	112	11	8				
	1,446	11	9				
ce, being excess of Income over Expenditure	53	8	3				
	£1,500	0	0		£1,500	0	0

st of office equipment, heating and lighting, onery, postage, etc., charged to the Associa- 's General Income and Expenditure Account connection with the Leverhulme Study up, amounted to £200 at March 31, 1959.

REPORT OF THE COUNCIL TO THE GENERAL COMMITTEE

1958–1959

(Received and adopted by the General Committee on September 2, 1959)

INTRODUCTION

1.

The report which was presented last year made it clear that the work—in respect of the programme of new activities—was necessarily still mainly in the planning stage. The period which has elapsed since the Glasgow Meeting has been one of intense activity and many of the plans made possible by the generosity of a relatively small number of industrial organisations have been put into operation with a remarkable degree of success. It is gratifying to report that the extension of the activities of the Association has received the enthusiastic support of many organisations and in particular, the schools. The Council wishes to thank all those individuals and organisations concerned with the presentation of science who have contributed—by service on Committees and in other ways—to the successful planning of its new activities. It is only possible, in this brief introduction, to refer to some of the highlights of the year. *Fuller accounts of the many activities are contained in the body of the report.*

2.

The Visit of H.R.H. the Duke of Edinburgh, K.G., F.R.S., to India and Pakistan.

H.R.H. Prince Philip, the Duke of Edinburgh, honoured the Association by representing it at meetings of sister Associations in India and Pakistan during the early months of 1959. He was accompanied by Sir Alexander Fleck, K.B.E., F.R.S., immediate Past President of the Association.

3.

Annual Meeting (*see page 251*)

The Council have reviewed the organisation of the Annual Meeting and propose to make a number of changes which they are confident will improve the balance of the programme as a whole. In future it is proposed that the President of the Association will be installed in office at a general assembly of members on the last day of the Annual Meeting preceding the Meeting over which he will preside and not, as now, at the beginning of each January. He will therefore be in office throughout the planning period for the Meeting over which he will preside.

The Council plan also to devote the whole of one day during the Cardiff Meeting in 1960 to a major general session on the world food position: in order that this shall prove to be an occasion worthy of the subject the many Sections concerned will be asked not to arrange competing programmes on that day.

The Council are pleased to report that the first appointments have been made to the Kelvin, Darwin and Lister lectures which are designed to encourage young scientists to convey in non-specialist language

the significance of their work. The first of these series of lectures will be given at the York Meeting.

As a result of the experience gained last year at Glasgow, it has been possible to work out a satisfactory form for the special young people's programme which it is planned will be organised each year in conjunction with the Annual Meeting. An outstanding programme has been arranged for York which includes illustrated lectures, an exhibition of science in schools, and a public open forum.

4.

Journal and Publications (*See page 250*)

It is planned to publish the Association's journal *The Advancement of Science* in a new format as from the spring of 1960. The journal, which will be directed mainly to the non-specialist and will contain articles intelligible to the informed layman with a general interest in science, will appear six instead of four times a year, as at present.

The Association has published—with the generous financial support of the Carnegie United Kingdom Trust—a new edition of the Directory of Natural History Societies.

5.

Area Committees (*See page 245*)

Area Committees have been established and are now at work in Newcastle-on-Tyne, on Tees-side, and in Durham, Cornwall, Sheffield and Nottingham. Other projects are under development at Birmingham, Bradford, Norwich, Southampton, Northern Ireland, South Wales, Suffolk and Essex.

Area Committees are arranging active and comprehensive programmes of lectures for audiences drawn from branches of other bodies in their regions as well as in schools. Since the autumn of 1958 Area Committees have arranged something like 125 lectures which were heard by audiences totalling 6,000 people.

It is hoped that before long Area Committees will develop into regional branches of the Association.

6.

Lecture Service (*See page 246*)

The Lecture Service organised by the Association has developed tremendously. Since October, 1958, a total of 105 lectures have been arranged from London—of which 50 were to adult audiences and 55 to school audiences. Up to April 30, 1959, the total audience for these lectures together with the lectures arranged by Area Committees has proved to be of the order of 26,000 people. Among the many organisations for which lectures have been provided are included branches of the W.E.A., Chambers of Commerce and the Institute of Industrial Supervisors.

7.

Young People (*See page 248*)

The Association has received a special grant to plan a programme aimed at encouraging scientific aptitudes among young people. After careful preliminary investigation work is now proceeding along the following lines—the possibility of a scientific magazine for young people, a study of ways in which science clubs in schools may be encouraged, the development of a visual aids programme designed to support the young people's programme as a whole.

8.

Visual Aids
(*See page 249*)

The Council has embarked on a study—in a chosen area—of the availability and use of visual aids in schools and particularly by science clubs. This study will, it is envisaged, make available not only the first detailed picture of its kind in this field but will provide invaluable guidance for sponsors, producers, distributors and users of visual material. The Council have, by their participation in this year's Festival of Films in the service of Industry at Harrogate—at which they made two awards—sought to identify themselves in mutually beneficial ways with the many industrial organisations which—with other organisations such as the Scientific Films Association and the British Universities Film Council—continue, as in the past to contribute so generously to the presentation of the Association's annual scientific film programme.

9.

Granada Lectures
(*See page 255*)

The Council are arranging, in co-operation with Granada TV Network Limited, a series of annual lectures on the problems of communication in the modern world. The first of this series of lectures will be given in London in October of this year, by Sir Edward Appleton, Sir Eric Ashby and Dr. Edward R. Murrow.

The Association are also co-operating with Granada TV Network Limited in organising a series of school television programmes on science.

10.

Study Groups
(*See page 252*)

The Study Group on the Metric System, under the Chairmanship of Sir Hugh Beaver, and that on the Education of the Graduate Scientist, under the Chairmanship of Sir Patrick Linstead, are making satisfactory progress and it is expected that the final reports will be ready before the Annual Meeting in 1960.

FINANCE

1. The General Treasurer has kept the Council informed of the state of the Association's finances and his statement of account for the financial year ending March 31, 1959, will be submitted to the General Committee.

2. The General Treasurer is pleased to report that the sum accruing from the first and second appeals has reached the total of £167,000 (including tax recoverable), the amount from the second appeal being approximately £102,000. The Council wish to record their gratitude to Sir Alexander Fleck in particular for the immense contribution which he made personally to the success of the appeal during his year of office.

3. The General Treasurer wishes to report also:

(i) That the Association's appeal to the Special Commissioners of Income Tax against the decision of the Inland Revenue authorities not to repay tax on certain covenanted subscriptions has been decided in favour of the Association and repayment of outstanding claims has been authorised in principle by the Board of Inland Revenue.

(ii) That the Association has been accepted by the Commissioners of Inland Revenue as an approved Society in respect of Section 16 of the Finance Act, 1958, and that the whole of the annual subscription paid by a member who qualifies for relief under that Section will be allowable as a deduction from his emoluments assessable to income tax.

OFFICERS AND COUNCIL

1. *President*, 1960

The Council will make a recommendation to the General Committee. [Sir George Thomson, F.R.S., was unanimously elected President for 1960.]

2. *General Officers*, 1959–60

The Council accepted with regret, in January 1959, the resignation of Dr. N. C. Wright, C.B., Honorary General Secretary, on his appointment as Deputy Director-General of F.A.O. in Rome. They wish to record their thanks to him for the invaluable work he undertook for the Association in the short time that he held his appointment of General Secretary.

The Council make the following nominations for the year 1959–60:

General Treasurer: Lord Rennell of Rodd, K.B.E., C.B.E.

General Secretaries: Dr. W. E. Swinton and Dame Kathleen Lonsdale, D.B.E., F.R.S.

3. *Other Members of Council*

Members retiring under Statute III, 3, are A. C. Hartley, Dame Kathleen Lonsdale, Dr. C. F. A. Pantin, Prof. P. E. Vernon, and Prof. S. W. Wooldridge. Under the powers given to them by Statutes, the Council nominate for appointment Prof. G. C. Varley, Prof. D. L. Linton, and Dr. N. A. B. Wilson, leaving two vacancies in the ordinary membership to be filled by the General Committee without nomination by Council. The following is a full list of nominations recommended for approval by the General Committee:

J. N. L. Baker
Prof. R. J. Brocklehurst
Dr. H. O. Bull
Prof. W. Burns
P. Ritchie Calder, C.B.E.
Prof. G. R. Clemo, F.R.S.
Prof. P. Sargant Florence, C.B.E.
Prof. T. N. George
Sir Ronald Gould
Prof. L. Hunter
Rev. Prof. E. O. James
Prof. D. L. Linton
James Macdonald, C.B.E.
Dr. B. J. Mason
Dr. H. G. Maule
L. R. Missen, C.M.G., M.C.
Dr. K. P. Oakley, F.B.A.
Dr. R. W. Powell
Dr. H. G. Sanders
Prof. O. A. Saunders, F.R.S.
Dr. R. E. Slade
Dr. C. J. Stubblefield, F.R.S.
Lord Netherthorpe of Anston
Dr. W. B. Turrill, O.B.E., F.R.S.
Prof. G. C. Varley
Dr. N. A. B. Wilson
Prof. T. Wilson, O.B.E.

[The General Committee approved the above nominations and appointed Dr. D. A. Allan, C.B.E., Dr. D. C. Martin, and Sir Ewart Smith, F.R.S., to fill the remaining vacancies.]

4. *Honorary Auditors*, 1959–60

The Council recommend the reappointment of Dr. H. G. Maule and Dr. D. B. Harden.

5. *Professional Auditors*, 1959–60

The Council recommend the reappointment of W. B. Keen and Co.

STAFF

Mr. A. M. Hughes has been appointed as Visual Aids Officer to the Association and Mrs. S. Campbell Smith to undertake the administration of the Lecture Service.

ANNUAL MEETINGS

1. *Glasgow Meeting*, 1958

The total attendance at the Glasgow Meeting was 2,839, a figure which included 817 local members and 908 student members. A narrative account of the Meeting appears on pp. 157–63 of *The Advancement of Science*, **15,** No. 59, December 1958.

2. *York Meeting*, 1959

Sir James Gray, C.B.E., M.C., F.R.S., was installed as President for the year at a general assembly of Committees of Sections, held in the Harkness Hall, Birkbeck College, on Friday, January 2, 1959.

The Council look forward with especial pleasure to the meeting in York where—one hundred and twenty-eight years ago—the Association was founded. Of the first Meeting—in 1831—it was said, 'To this city as the cradle of the Association we shall ever look back with gratitude, and, whether we meet hereafter on the banks of the Isis, Cam or the Forth, we shall return to this point of our first attraction.'

The Council gratefully acknowledge the willing and generous help given by Local Officers and Committees in making their preparations for this, the sixth Meeting in York—preparations which, especially in a non-University City, demand—and have secured—a continuing devotion of effort and enthusiasm.

The Council are indebted to the Local Committee for the publication of a Scientific Survey of the York region which will be offered free of charge to all members. A special programme for young people has been arranged in conjunction with the Chief Education Officer and a Committee of Teachers representative of schools in the York region.

3. *Cardiff*, 1960

A local General Committee has been set up under the Chairmanship of The Lord Mayor of Cardiff to make arrangements for the meeting which will take place from August 31 to September 7, 1960.

The following have accepted the Council's invitation to serve as Presidents of Sections at Cardiff:

Section		*Section*	
A	Dr. R. van der Riet Woolley, O.B.E., F.R.S.	I	Prof. W. Burns
B	Dr. James Taylor, M.B.E.	J	Prof. R. C. Oldfield
C	Mr. G. F. Mitchell	K	Prof. T. M. Harris, F.R.S.
D	Dr. G. S. Carter	K*	Mr. T. R. Peace
E	Prof. E. G. Bowen	L	Prof. H. C. Dent
F	Prof. R. S. Sayers, F.B.A.	M	Dr. W. Davies
G	Sir Alfred Puglsey, O.B.E., F.R.S.	N	Prof. D. V. Glass
H	Prof. E. Estyn Evans	X	Mr. A. B. Oldfield-Davies

FUTURE ANNUAL MEETINGS

1. *Norwich*, 1961

The Council have received an invitation from the City of Norwich to hold the 1961 Meeting there and they unanimously recommend its acceptance.

2. *Manchester*, 1962

The Council have received a joint invitation from the City and the University of Manchester to hold the Annual Meeting there in 1962 or 1963. This invitation has been provisionally accepted for 1962 and the Council unanimously recommend that acceptance be confirmed.

3. *Southampton*, 1964

The Council have received and recommend for acceptance an invitation from the City and the University of Southampton to meet in Southampton in 1964.

[The General Committee accepted each of these invitations with acclamation.]

AREA COMMITTEES

When last year's report was written, no Area Committees had actually been established. By the time of the Annual Meeting in Glasgow, Committees had been formed at Newcastle-on-Tyne and on Tees-side, and they were busy organising programmes of lectures for the winter. In October the Durham Committee was established, and it at once adopted a programme which had been arranged in advance by the Director of Extra-Mural Studies, the Board having agreed that the Department should act as the host for the Area Committee. In November, the Cornwall Committee was formed, in January that at Sheffield, and in March that at Nottingham.

The Officers of the Committees already established are:

Newcastle-on-Tyne.—Emeritus Prof. G. R. Clemo, F.R.S. (Chairman); Mr. A. P. Miller and Mr. R. D. Harrison (Joint Secretaries); Mr. B. W. Abrahart (Treasurer).
Tees-side.—Dr. I. J. Faulkner (Chairman); Dr. J. McAnuff and Mr. G. W. Ettle (Joint Secretaries).
Durham.—Prof. D. H. Valentine (Chairman); Mr. H. J. Boyden (Secretary).
Cornwall.—Air Marshal Sir John Tremayne, K.C.B., C.B.E., D.S.O. (Chairman); Mr. J. E. Montgomery (Vice-Chairman); Mr. C. S. Smith (Secretary).
Sheffield.—Mr. W. H. Wilcockson (Chairman); Dr. H. D. Turner (Secretary).
Nottingham.—Prof. L. F. Bates, F.R.S. (Chairman); Mr. H. C. Wiltshire (Secretary).

A number of other projects are in various stages of development, at Birmingham, Bradford, Norwich and Southampton, in Northern Ireland, South Wales, Suffolk and Essex. It is hoped that some of these will have been established before this report is presented to the General Committee, and indeed that some will have time to prepare programmes of lectures for the autumn and winter of this year.

The three original Committees in the north-eastern Region each arranged programmes of some fifty lectures for their first sessions. The programmes were frankly experimental; inevitably some mistakes were made from which most valuable lessons were learned. Audiences were mostly sought from bodies accustomed to meeting together, either schools or adult organisations such as Women's Institutes, Rotary Clubs, Trades Unions, Townswomen's Guilds, and so on. Among adult audiences, it was noticeable that women's organisations formed a high proportion. This was most encouraging. It may have been due to their being more accustomed to regular meetings for lectures; whatever the cause, it enabled much useful work to be done. Increasing success was obtained in securing, through representatives on the Committees, joint audiences from more than one organisation, and in some instances this has been in itself a useful service. The extent to which individual Committees have concentrated upon adult audiences, or upon lectures to schools, or have covered both types in varying proportions, has depended upon local circumstances and the extent to which particular parts of the field were already being covered, or upon the possibility of arranging audiences. Throughout, the aim has been to avoid duplication of effort and to choose in each area the target which would give the most efficient use of the available resources.

A typical programme was that of the Newcastle-on-Tyne Committee. Between October 1, 1958, and the middle of March, 1959, forty-seven lectures were arranged. The largest single audience was 160, a large Rotary Club; in fact this was the only audience over 100. The smallest was 9. Otherwise nearly all audiences were between 25 and 75, with an average of 40. The total expenses of the Committee, for overhead charges and for lecturers' expenses, were £264 for this period. The Council considers that this represents most efficient application of the funds made available.

Special mention should be made of two programmes for schools, in Cornwall and Nottingham. The Cornwall Committee, as its first venture, arranged a three-day programme for schools, at Liskeard and Redruth, just before Easter. Over two thousand schoolchildren were brought in from all over the County, some audiences being from the Sixth Form and others under sixteen years of age (including children from Secondary

Modern schools). All audiences included both science and arts specialists. At the time of writing, the Nottingham Committee is planning a similar programme, to last for three days in July and to cover nearly four thousand children; and it is hoped that the programme will include scientific films and exhibitions. These two events, organised by Area Committees, are in fact, the first extensions to an all-the-year-round country-wide basis of the Young People's Programme which was organised at Glasgow at the time of the Annual Meeting last year.

Committees are now busy either reviewing the first season of work or planning the programmes for next winter. Particular emphasis is being placed upon obtaining better coverage of the area, and securing larger audiences and a better balance as between subjects and audiences.

Committees normally consist of a nucleus of scientists, and then on the one hand representatives of all the bodies engaged in teaching or presenting science (Extra Mural Departments, Education Authorities, Technical Colleges, Museums, Scientific Societies, Professional Institutions, W.E.A., etc.) and on the other hand of audience-producing organisations. In some cases there are also representatives of leading industrial firms on the Committee. Since the Association has no local offices, the Committee relies upon some organisation acting as host to it, and providing a home, an office and secretarial assistance.

The Council are most grateful to the officers and members of these Area Committees, to the local organisations which have acted as hosts to the Committees, and to the scientists who have undertaken to help Committees by giving lectures. There has been great kindness to the Association and much hard work by a very large number of people, without which the programme could never have developed as it has. The Council believes profoundly in the importance of this work, and hopes that the amazingly generous acceptance of the Association's incursion into this field is evidence both that their belief is shared by a great many scientists, and also that the Association has been able to make a valuable contribution.

In addition to the committees which have been established as Committees of the Association, the Council has been pleased to give assistance, in varying degrees and forms, to existing local organisations engaged upon the same work. Among these may be noted the Manchester Federation of Scientific Societies; the Committee established by the Reading Education Committee under the chairmanship of Sir John Wolfenden; the Worthing Scientific Society newly established through the initiative of the Mayor; the Extra-Mural Department of Glasgow University, with which the Association is collaborating in providing scientific lectures in the western highlands and islands of Scotland, and the Council for Education in World Citizenship whose project on the arid zones is a most suitable subject for joint effort.

LECTURE SERVICE

The service of lectures organised by the head office of the Association for places where there is no Area Committee has developed as rapidly as the system of Area Committees. Mrs. S. Campbell Smith was appointed to the staff of the Association for the purposes of the lecture service, and the rapid progress made has fully justified the appointment.

From October 1, 1958, a total of 105 lectures has been arranged from head office, of which 50 were to adult audiences (amounting in all to some 6,400) and 55 were to school audiences (amounting in all to some 13,500). These figures are considered eminently satisfactory, since the service has been operated on the basis that every request has been met when it has been at all possible to do so. Only once has it not been possible to meet a request, when the notice was short, the subject one where speakers are few and much in demand, and the organisation were unable to alter their meeting date to suit possible speakers.

Adult audiences have come mainly from the principal and well-known organisations which arrange lecture programmes including not only those mentioned above in relation to Area Committees, but also the National Council of Women, Boys' Clubs, and lecture

societies. Once again the preponderance of women's organisations may be noted. There are some particular occasions which merit special mention. In May, at the request of the Bishop of Peterborough, a speaker was invited to address a large church group on radiation hazards and their implications. In June, a lecture has been arranged for the National Institute for Adult Education in London. Several lectures have been arranged for the Institute of Industrial Supervisors, mostly dealing with automation and ergonomics. Audiences have been well distributed over the country—Lancashire and Yorkshire; West Midlands, East Midlands and East Anglia; Devonshire, Somerset, Hampshire, the Home Counties and London.

As has been noted above, school audiences have been of many different kinds. There have been large audiences, gathered together by education authorities or by local co-operation between headmasters from a number of schools. There have also been small audiences, down to the individual school science club. There have been residential courses for science sixth formers, and for arts sixth formers. The total audience of 13,500 has been divided almost equally between boys and girls.

The standard of the lectures has been exceedingly high, and many of the most eminent and able exponents of science have taken part in the service. The results achieved show clearly that lectures of this sort, given by speakers having the gift of presenting their subject are very effective even if facilities for demonstration are limited, and even with audiences (such as children under 16) for whom demonstrations are normally so important. Good presentation, supported by not more demonstration equipment than can be easily transported, will definitely prove effective. The panel of lecturers is now some hundreds strong, and the Council is most grateful to them both for the lectures they have given, and for the invaluable assistance they have given, when unable to undertake a lecture themselves, in suggesting others who might do so. This generous help has not only increased the size of the panel, but has enabled the Association to predict, with some confidence, that given sufficient notice a first-class speaker can be found for almost any part of the country, for almost any type of audience, on almost any scientific topic. This is a great deal to undertake, and it would not have been thought possible, until the kindness of a very large number of scientists proved it so. How long it will be possible to maintain the position if the number of lectures given continues to grow cannot be predicted.

The service has been provided with most remarkable financial economy. It has been said that no request has been refused, and on finance the approach has been that the Association is able, through the funds so generously provided by industry, to bear the whole of the costs of the lectures; but where the organisation providing the audience is able to make a contribution towards the costs, this is always welcome because it enables more to be undertaken. The members of the panel have also been most generous in their approach, and have been willing to lecture for the Association for expenses and a small fee. As a result, during the first quarter of 1959 thirty-three lectures were given for a net cost (fees and expenses less contributions) of £147. This represents great efficiency in expenditure, and the Council can only express their gratitude to all who have made it possible.

The distribution of the lectures between subjects was as shown in the table on p. 248.

The preponderance of lectures on atomic energy, nuclear physics and radiation hazards reflects the degree of public interest and concern, as much among adults as among children, and also the activities of the extremely fine panel of speakers recommended to the Association by the Atomic Scientists' Association under the arrangement reported in paragraph 31 of last year's report. Demand, interest, the availability of many fine speakers, the importance of the implications, and the remoteness from the normal school curriculum have made these lectures almost ideal as the first lecture to adult or school audiences. The Council is glad to have been able to make this contribution to the work of the Atomic Scientists' Association, but hopes that it will be possible to increase the proportion of lectures on other subjects. The distribution also reflects the difficulty of chemistry as a subject for general audiences.

Atomic energy, nuclear physics and radiation hazards	41
Biology	11
Physics	7
Psychology	6
Physiology	4
Nutrition	4
Astronomy	3
World population and food supplies	3
Automation	2
Chemotherapy	2
Textiles	2
Chemistry	1
Chemical aeronomy	1
Geology	1
Archaeology	1
General subjects not falling within any single discipline	16
Total	105

YOUNG PEOPLE'S PROGRAMME

During the past year the Shell Petroleum Company, with great generosity, made available to the Association the results of a survey they had undertaken for a campaign, aimed at young people during the formative years, and designed to discern and encourage scientific aptitudes where they existed and, where they did not, to implant some appreciation of the place of science in modern life, which would never afterwards be lost; they also made a large donation which enabled work to implement the programme to be begun.

The programme was inevitably concerned with a great many authorities in a number of fields. A Planning Committee was therefore established, under the Chairmanship of Sir Ben Lockspeiser, K.C.B., F.R.S., containing representatives of all organisations likely to be affected, and it was given general oversight of the work of three particular committees.

The programme has obvious connections with the lecture service to schools, and also with the special problem of introducing science in primary schools as well as teaching of science in the early stages in secondary schools. Steps have therefore been taken from the outset to obtain the collaboration of teachers' organisations and of education authorities, and much valuable assistance has been received already. In particular, the Teachers' Training Colleges are most important, both as regards those who are going to teach science and those who are going to teach other subjects. An approach has therefore been made to all Teachers' Training Colleges with a view to extending the lecture service to them.

The lines along which, after much careful preliminary investigation, work is now proceeding are firstly, attempting to find a commercial publisher who will undertake the publication of a scientific magazine for young people in collaboration with the Association; secondly further examination of the position regarding science clubs in schools, and particularly secondary modern schools with a view to the possible formation of a federation of such clubs; and thirdly, the development of the visual aids programme in the manner described opposite.

INTERNATIONAL YOUTH SCIENCE FORTNIGHT

The Association has collaborated with Worldfriends, an exchange organisation which has consultative status with U.N.E.S.C.O. and is the British member of the World Friendship

Federation, in making arrangements for the first London International Youth Science Fortnight. Worldfriends has for many years organised an International Youth Fortnight in London, during which young people from many countries come and stay with British families having children of similar age. Increasingly, following Lord Tweedsmuir's dictum that those of similar interests make the best friends, they have sought to give these meetings a theme, and they thought of science as a theme and sought the collaboration of the Association in the arrangement of a scientific programme. In view of the commitments of the Association regarding the international relations of science, the Council was pleased to collaborate in this project, and to arrange with the very kind co-operation of lecturers and many firms and research establishments a most comprehensive scientific programme giving, within the limits imposed by making visits each day from London, a general picture of the achievements of British science.

VISUAL AIDS

The use of visual aids has been envisaged by Council as an integral part of the Young People's Programme. In the summer of 1958 representatives of the following organisations were invited to serve on a Visual Aids Committee under the Chairmanship of Sir Ben Lockspeiser: the Association of Women Science Teachers, the British Universities Films Council, *Encyclopaedia Britannica*, the Educational Foundation for Visual Aids, the London Institute of Education, Queen Mary College, the Science Masters' Association, the Scientific Film Association, the Scottish Education Department, the Shell Petroleum Company, and Unilever.

A Visual Aids Officer was appointed in November 1958. In the light of his findings in a preliminary survey of the use of visual aids in relation to the Young People's Programme it was decided that the Association could best supplement the work of other organisations by making a detailed study of the use of visual aids in relation to science clubs and science teaching in one Local Education Authority area. With the very ready co-operation of the Chief Education Officer and his Visual Aids Officer such an area has now been selected. It has been chosen because it presents as wide a variety of conditions as possible—including highly industrialised districts, scattered rural areas, old-established County towns, and entirely new urban communities.

A survey in this area, using available statistical information as a background for detailed investigation of selected districts and schools will not only supplement more general information already being gathered from many authorities, but will also provide an informative picture of the practical problems encountered in the use of visual material. Such information will provide a basis for future British Association activity and suggest fruitful lines of development for all working in this field.

Enjoying, as it does, the support of both scientists and industry, the Association is well placed to transmit suggestions about the most suitable form and content for new visual aids for science teaching, and to influence both sponsor, producer, and user. A first step in this direction was taken by Council when it became closely identified with the Harrogate Festival of Films in the Service of Industry. Council presented two Diplomas of Merit at the 1959 Festival, one for the British film screened at the Festival which best presented science to the public, the other to that British film which offered the best exposition of the scientific principles underlying an industrial process.

Films have, for many years, been used to illustrate papers in Section Meetings and in 1955, at the Annual Meeting in Bristol, Council included a full week's programme of science films. Such a programme has since become an established and popular feature, and at the York Meeting the Association will, for the first time, present Certificates of Participation to the producers of the films selected for screening.

Films are, of course, but one of many valuable visual aids. A perennial problem is that of ensuring that adequate use is made of the abundance of visual material available. The Association is helping to ensure its more effective use, firstly by providing appropriate visual aids in connection with its own courses, conferences, lectures, and other activities;

secondly by introducing scientists to existing material and to available sources of information in a newly-introduced Visual Aids Section in *The Advancement of Science*; and thirdly by co-operating with many individuals and organisations in the selection and presentation of visual aids. Thus the Association has co-operated with Area Committees, with local authorities such as Buckinghamshire and Reading, with industrial organisations such as the Crittall Manufacturing Company and Metal Industries, with educational and voluntary bodies such as the National Institute of Adult Education and the Council for Education in World Citizenship, and with a variety of individual specialists concerned with the presentation of science in schools, universities, and on television.

REVISION OF THE STATUTES

The Council wish to report that in view of the considerable extension of the Association's activities now being undertaken they have deemed it desirable to consider how these activities can properly be fitted into the constitutional framework of the Association. The Council submit—in Appendix A—their recommendations to the General Committee regarding the necessary revision of the statutes.

PUBLICATIONS

1. *The Advancement of Science*

The Council report that they are in accord with the belief expressed by the Editorial Committee that in view of the current and planned future expansion of the activities of the Association, it will be important to provide a Journal which will be read by a wider public. They have, therefore, accepted the following recommendations:

(i) That *The Advancement of Science* should be directed mainly to the scientific non-specialist and contain articles intelligible to the informed layman. Articles should be written in a language intelligible to scientists working in other fields. The journal, however, should not in any sense be a 'popular' journal.

(ii) That material of special interest to members, such as lists of office bearers, the Report of the Council to the General Committee and the records of Sectional transactions at the Annual Meeting (including abstracts of the papers and references to publication) should be published in a separate Annual Report and not, as now, in *The Advancement of Science*.

(iii) That *The Advancement of Science* should be published in a new format and should appear six, instead of four, times a year.

2. *Directory of Natural History Societies*

The Directory of Natural History Societies and other Field Study Societies in Great Britain, the production of which was made possible by a generous grant from the Carnegie United Kingdom Trust was published by the Association on March 6, 1959, at a price of 20*s*., plus 1*s*. 6*d*. for packing and postage.

The Directory covers archaeological, astronomical, biological, botanical, geographical, geological, meteorological and zoological societies—both national and local amateur bodies—and other cognate societies. The information given for each society is listed under the following headings: title and address, name and address of Secretaries, aims and objects, conditions of membership, amenities, meetings, publications and affiliations. Societies are arranged alphabetically under the main headings of natural history, archaeology, archaeology and natural history, societies with general interests, geology, astronomy, and meteorology. The arrangement of the societies within the sections is strictly alphabetical according to the titles supplied by the Secretaries. There is a final geographical reference section in which the names of the societies are listed alphabetically according to counties.

The Council of the Association hopes that the publication of the Directory which contains information about some 800 societies will stimulate field studies throughout the country and will encourage co-operation between professional and amateur scientists.

The Carnegie United Kingdom Trust have also most generously decided that the revenue from the sales of the Directory should be retained by the Association and used to finance the publication of revised editions in the future.

ANNUAL MEETING COMMITTEE

During the autumn of 1958 the Council appointed a Committee to consider the present organisation of the Annual Meeting. The following are amongst the most important of its recommendations:

(i) That the expenses incurred in connection with certain categories of visitors to the Meeting, such as overseas guests and student exhibitioners, should in future be borne by the Association.

(ii) That in special cases contributions to a Local Committee towards the local cost of the Meeting might be made by the Council for specific purposes to be determined by the Council.

(iii) That the Annual Meeting should not in future be held in a small and/or non-University city more than once in five years.

(iv) That the period of office of the President of the Association should in future run from the end of the Annual Meeting to the end of the next Annual Meeting, instead of from January 1 to December 31 as at present.

(v) That the programme should be re-arranged so as to make possible a general assembly of members on the final Wednesday morning of the Meeting at which the new President would be installed.

DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE

It was reported a year ago that an Atomic Scientists' Sub-Committee of the Division had been set up to bring before the public of the United Kingdom the facts about atomic energy and their implications.

The Council now report that they have accepted a recommendation from the Committee of the Division that it should take over the work of the Radiation Hazards Study Group of the Atomic Scientists' Association. The Council have agreed that the General Officers (or individuals nominated by them) should be empowered, when the need arose, to authorise public statements on matters within the Study Group's field of inquiry and that the Association should have the power to appoint its own representatives to the Study Group. The Group's aims include the following: To make objective assessments of the numerous statements which are made these days about various radiation effects, whether from diagnostic procedures, reactor accidents, or fall-out.

The present members of the Study Group are:

Prof. J. Rotblat (Chairman)
Dr. J. W. Boag
Dr. C. E. Ford
Prof. A. Haddow, F.R.S.
Dr. W. M. Levitt
Dr. Patricia J. Lindop
S. B. Osborn, Esq.
Prof. L. S. Penrose, F.R.S.
Prof. P. A. Sheppard
Dr. A. J. Salmon
Dr. G. Simon

SCIENCE AND INDUSTRY COMMITTEE

The Science and Industry Committee, first appointed in 1952, will complete its work at a meeting on December 3, 1959. The Committee's third published report—*Science in*

Industry: Policy for Progress—will appear in October or November, 1959 and the Council has agreed to arrange conferences, arising out of subjects dealt with in the book, in a number of centres.

A final report of the work of the Committee will be presented to the Council after the meeting to be held on December 3.

SPECIAL LECTURESHIPS

The Council are pleased to report that the first appointments have been made to the special lectureships, the establishment of which was announced at the Glasgow Meeting. The following have been appointed to deliver lectures at the York Meeting:

Kelvin Lecture: Dr. S. Brenner, M.R.C. Unit for Molecular Biology, Cavendish Laboratory, Cambridge.
Darwin Lecture: Dr. R. G. West, Demonstrator in Botany, University of Cambridge.
Lister Lecture: Mr. Donald Broadbent, Director of the Applied Psychology Research Unit, Cambridge.

SOCIOLOGY COMMITTEE

The Council have appointed a Committee of Sociologists to consider whether they felt:

(*a*) that the Association could provide a suitable platform for sociological papers;
(*b*) that the sociologists could produce effective programmes each year, and
(*c*) that the best way of meeting the claims of Sociology would be to set up a separate Section or sub-Section and, if the latter, to indicate which of the existing Sections would be the most appropriate parent Section.

The following have been appointed to serve on this Committee: The General Officers (*ex officio*), Prof. D. V. Glass, Dr. Hilde Himmelweit, Dr. Lucy Mair, Prof. P. Sargant Florence and Mr. Keith Kelsall (appointed by the British Sociological Association), Prof. Daryll Forde and Prof. M. Fortes (appointed by the Association of Social Anthropologists).

STUDY GROUP ON THE METRIC SYSTEM

The Committee set up under the Chairmanship of Sir Hugh Beaver to examine the practicability, implications and cost of a change-over to the metric system of weights and measures and the decimalisation of the coinage in the U.K., began its work in 1958. At the outset it was found that a Committee with almost identical terms of reference had been set up about the same time by the Association of British Chambers of Commerce. In order to avoid making a dual approach to companies and institutions to obtain evidence, the two Committees have been working in close co-operation and all evidence for both Committees has been sought by means of joint questionnaires.

The Committee decided that as the questions of weights and measures and coinage had such a wide application it was necessary to obtain evidence from a very broad cross-section of industry, commerce and other interests. Evidence has therefore been sought from the following sources:

Trade Associations

These Associations, representing specific sectors of industry and commerce and in some cases having membership consisting of several hundreds of individual firms, were invited to give evidence on behalf of their members.

Individual Companies in Industry and Commerce

Selected companies covering all branches of industry and commerce, some being selected from the largest groups in the country and others representing smaller units.

The Public Utilities

All the large public utilities in the country were invited to give evidence—British Transport Commission, National Coal Board, Electricity Council, Gas Council, B.O.A.C., B.E.A., U.K. Atomic Energy Authority.

Learned Societies and Professional Institutes

Nearly 100 bodies were invited to give the views of their members or professions.

Educational Authorities

A special questionnaire dealing with the educational aspects of the enquiry was sent to a number of educational authorities and teachers' associations.

Local Authorities

Evidence has been sought from a cross-section of Local Authorities throughout the country. Those authorities with educational responsibilities were also asked to deal particularly with the educational aspects of the investigation.

Government Departments

The Board of Trade has been assisting the Committee throughout and questionnaires prepared in consultation with the Board of Trade have been sent to all Government Departments who are considered to be materially affected by the questions under review.

Special Evidence

Special evidence is also being sought from certain bodies who would be particularly affected by any change in weights and measures or coinage—the accounting machine manufacturers, the weighing machine manufacturers, vending machine manufacturers, petrol pump manufacturers.

Overseas enquiries

In order to obtain some views on the overseas implications of any change in weights and measures or coinage by the U.K., evidence has been sought from some forty Trade Commissioners overseas in countries using both the metric and non-metric systems. These countries represent over 80 per cent. of our export trade and the Trade Commissioners have been invited to comment particularly on the possible effects which a change in our system of weights and measures or coinage would have on our export trade to the countries concerned.

Information has also been sought from bodies in India (where decimal coinage was introduced in 1957 and the change to the metric system of weights and measures is now taking place), South Africa (where the Government has approved a change to decimal coinage to take place in 1961), Australia (where a decimal coinage Committee has been set up by the Government) and Japan (where the metric system has now become the sole official system of weights and measures).

The bulk of the evidence has now been received by the Committee and is being analysed and processed. The Committee expects the Report to be completed in the next few months.

STUDY GROUP ON THE EDUCATION OF THE GRADUATE SCIENTIST IN SCHOOL AND UNIVERSITY

The Leverhulme Study Group, appointed by the British Association to examine and report on the education in school and university of students of science and technology started work in October with a grant from the Leverhulme Trust Fund.

For information on the practice of schools, the Group have decided to concentrate on England and Wales and to rely largely on existing material in the form of the surveys carried out by certain Divisions of the Incorporated Associations of Head Masters and by the Association of Head Mistresses for the Central Advisory Council's recent enquiry

into the educational needs of boys and girls between fifteen and eighteen. The Group have however undertaken a small follow-up designed to discover how far practice has changed in the meantime and to provide information relating specifically to pupils trying for a university.

A small number of heads of schools, from among those replying to the questionnaire, have been asked at a later stage to answer questions about their policy and views.

Parallel questionnaires have also been sent to three colleges of the Universities of Cambridge and of London and to seven other university bodies in Great Britain. In an attempt to keep the material within manageable bounds, and also out of consideration for hard-pressed Registrars, questions about the pursuit of non-scientific subjects by undergraduates have been limited to those reading mathematics, physics, chemistry or general science, electrical engineering or mechanical engineering.

Again, a small number of senior members of the universities approached have been asked at a later stage to answer questions about their policy and views.

It has been decided, in addition, to seek the views of some members of professional institutions and some industrialists on the education of scientists and technologists.

An attempt is being made to discover the present cost of educating a science specialist in the sixth form and of an undergraduate and postgraduate student of science and of technology, against the possibility of any recommendation of the Group requiring greater expenditure.

RELATIONS WITH INSTITUTIONS OVERSEAS

The Council have great pleasure in reporting that H.R.H. Prince Philip, Duke of Edinburgh, K.G., F.R.S., honoured the Association by representing it at the Annual Meeting this year of the Indian Science Congress, in New Delhi in January 1959, and of the Pakistan Association for the Advancement of Science, in Karachi in February 1959. His Royal Highness, who was accompanied by Sir Alexander Fleck, K.B.E., F.R.S., delivered addresses at the Inaugural Meetings of both bodies (see *Advancement of Science* XV, 60, March 1959). The Council are of the opinion that as a result of His Royal Highness's visit there is likely to be a closer relationship than ever before between this country and India and Pakistan and a renewed realisation of the part that science can play in the development, so urgently needed, in those countries.

The Council have also been represented at the following meetings of scientific bodies overseas:

(i) Annual Meeting of the Spanish Association for the Advancement of Science, Madrid, November 1958: Sir Ben Lockspeiser, K.C.B., F.R.S.

(ii) Centenary Zoological Congress, Singapore, December 2–9, 1958: Prof. H. H. Munro-Fox, F.R.S.

(iii) Annual Meeting of the Ceylon Association for the Advancement of Science, Colombo, December 18–20, 1958: Prof. H. H. Munro-Fox, F.R.S.

(iv) Annual Meeting of the French Association for the Advancement of Science, at Angers, July 20–25, 1959: Lord Rennell of Rodd, K.B.E., C.B.

(v) International Oceanographical Congress, New York, September 1959: Dr. H. O. Bull.

A number of distinguished scientists from overseas, including representatives of sister Associations have been invited to attend the York Meeting and the Council is pleased to report that among them will be Dr. Wallace Brode, Science Adviser to the Department of State, Washington, U.S.A., representing the American Association for the Advancement of Science; Dr. Y. Shefer, representing the Israel Association for the Advancement of Science; Prof. L. DeParis representing the French Association, and Prof. E. D. Mountain representing the South African Association.

The Council have welcomed a proposal made by the Council of the American Association for the Advancement of Science for the creation of an exchange lectureship which

would enable a distinguished scientist—appointed by each of the Associations in turn—to deliver a lecture on a topic of broad scientific interest at each other's Annual Meeting.

U.N.E.S.C.O.

The Council is pleased to report that it has made a nomination for the award of the Kalinga Prize for 1959, the purpose of which is to offer recognition to leading interpreters of science and to strengthen the links between India and the scientists of other countries.

The Secretary of the Association has been appointed to serve as a member of the Promotion of Science Panel which advises the British National Committee of U.N.E.S.C.O.

The Council have once again offered twenty complimentary memberships to members of the Overseas Science Students Association in London and to overseas science students at universities and colleges in other parts of the country to enable them to attend the York Meeting. They acknowledge with gratitude the financial help offered in this connection by the British Council.

THE PRESENTATION OF SCIENCE AND THE ASSOCIATION'S RELATIONSHIPS WITH INSTITUTIONS IN THIS COUNTRY

The Council have maintained and developed their relations with many individuals and institutions at home as well as abroad.

1. *British Broadcasting Corporation*

Sir Cyril Hinshelwood (President of the Royal Society), Sir Alexander Fleck (President of the British Association) and Sir Alexander Todd (Chairman of the Advisory Council on Scientific Policy) have met Sir Ian Jacob, K.B.E., C.B., Director-General of the B.B.C. to discuss the place of science in broadcasting. The view was expressed at the meeting that the B.B.C. did not completely meet with the needs of the present day in view of the rapidly increasing importance of science in everyday affairs. The B.B.C. were asked if the proportion of time devoted to scientific subjects, particularly on television, could be increased and whether an appropriate senior officer could be appointed at top policy level, to be in general charge of science broadcasting. A title of Controller (Science Broadcasting) or Head or Director of Science Broadcasting was suggested and it was felt that this would put science on at least an equal footing in the organisational set-up of the B.B.C. as religious broadcasting and educational broadcasting. The Director-General stated that the views expressed would be fully considered by the B.B.C.

2. *The Parliamentary and Scientific Committee*

The President and the Secretary attended a small dinner in the House of Commons arranged by the Chairman of the Parliamentary and Scientific Committee to discuss the presentation of science to the country and to consider what help the Committee could give to overcome financial or other obstacles. Sir Cyril Hinshelwood, P.R.S., Dr. D. C. Martin, Sir Lawrence Bragg, F.R.S., and Dr. Morrison-Scott and Sir Gavin de Beer, F.R.S. also attended.

3. *Granada TV Network Limited*

(*a*) Granada Lectures

The Council have agreed to undertake in collaboration with Granada TV Network Limited the arrangements for a series of annual lectures on the problems of communication in the modern world. The Council have appointed Sir Edward Appleton, Sir Eric Ashby and Dr. Edward R. Murrow to deliver the first of this series of lectures—which will be given in London to an invited audience during October 1959, and will be televised at the same time.

(*b*) Science for Schools

In February 1959, the British Association was approached by Sir Gerald Barr asking for co-operation in organising a series of television programmes on science to be broadcast by the Granada TV Network Limited. Discussions took place with representatives of the Headmasters and Headmistresses Associations and the Science Masters' Association, and as a result, programmes will be put out in co-operation with the British Association for the Advancement of Science.

4. *Annual Science Survey*

The Council have expressed their interest in a proposal made by Hulton's Press to publish—under the general editorship of Mr. A. W. Haslett—an Annual Science Survey. Officers of Sections have been invited to give help and advice to Mr. Haslett in respect of papers which may be given at this year's Meeting. It is expected that the first edition of the Survey will appear during the Spring of 1960.

5. *Grant from Charitable Foundation*

The Council report that they have authorised the making of an application to one of the charitable foundations for a grant of £10,000 to be expended over a period of three years on the provision for the W.E.A. of lectures and courses on science and for a pilot experiment requiring the appointment of a full-time staff tutor in science. The application was based on a memorandum prepared after full discussion with, and with the support of, the Workers' Educational Association. If a grant is made to the British Association for these purposes, full details of the projects will be submitted to Council for approval before any expenditure is incurred.

6. *Grants to Students*

The Council report that they have—at the invitation of the Ministry of Education and with the advice of the Committee of Section L (Education)—submitted a memorandum on the subject of grants to students to the Ministry for consideration by the Anderson Committee.

7. *Planning Committee for Education Conference*

The British Association was represented on the Planning Committee for an Education Conference being organised by the University of Oxford, to be held from July 26–August 6, 1959, on the subject of science as a general study in the Sixth Form. The Conference will be opened by Sir Lawrence Bragg and will be attended by approximately a hundred senior science teachers from the grammar and public schools and representatives of various administrative bodies concerned with education.

THE PRESS AND PUBLIC RELATIONS

The Council report that each Section has appointed a Press Secretary and that a meeting will be arranged—before York—to consider the ways in which the service offered to the representatives of the press, radio and television authorities present at the Annual Meeting may be given greatest effect.

A number of articles on the policy and activity of the Association have been contributed by Prof. P. M. S. Blackett and others to *Progress*, *Impulse*, *Discovery*, *World's Press News* and other journals.

Members of the staff have, in addition, given talks on a number of occasions and to a variety of audiences in different parts of the country on the Association's aims and work.

The Council have agreed that the office of the Association should provide a meeting place and secretarial help for the Association of British Science Writers.

RESOLUTIONS AND RECOMMENDATIONS

The Council report that they have, on the recommendation of the Committee of Section H (Anthropology and Archaeology) agreed that the title of the Section should revert to *Section H (Anthropology)*.

BIOLOGICAL STATIONS

The Council report that they have renewed, during 1959, grants of £50 each to the Freshwater Stations at Plymouth and Windermere and £100 to the Naples Station. In order to ensure that more effective use is made of the B.A. Tables letters have been sent to the Heads of the appropriate departments in Universities asking them to advise those working in their departments of the facilities available.

PRIZES

South Africa Medal

The Council report that the South Africa Medal has been awarded by the South African Association for the Advancement of Science to Dr. Margaret Levyns.

2. *The Endeavour Essay Prize*, 1959

The Council have accepted, once again, an invitation from the publishers of *Endeavour* to join with them in making arrangements for an essay competition in connection with the York Meeting. The subjects are as follows:

New sources of power	The mechanism of inheritance
Transport in the modern world	Enzymes
The exploration of space	Man-made fibres

This year, for the first time, a special prize will be awarded for an essay on any scientific subject of a candidate's own choice. The successful competitors, Mr. P. M. A. Broda (first prize), Mr. C. Fisher (second prize), Mr. R. D. Preece (special prize), Miss L. A. Whibley (special prize), Mr. A. H. Baillie (special prize) will be received during the York Meeting, together with the student exhibitioners, by the President and other officers and their prizes presented to them on this occasion.

RESEARCH COMMITTEES

Following the Glasgow Meeting the Council appointed ten Research Committees on the recommendation of Sections and made grants to two of them from the funds under their control. The Committees, with their terms of reference and membership are listed below:

Section A—Mathematics and Physics

Seismological investigations.—Dr. R. Stoneley, F.R.S. (Chairman), Mr. E. Tillotson (Secretary), Mr. E. F. Baxter, Miss E. F. Bellamy, Prof. P. G. H. Boswell, O.B.E., F.R.S., Mr. B. C. Browne, Sir Edward Bullard, F.R.S., Dr. K. F. Chackett, Dr. G. E. R. Deacon, F.R.S., Dr. A. T. J. Dollar, Dr. A. E. M. Geddes, O.B.E., Prof. G. R. Goldsbrough, C.B.E., F.R.S., Dr. M. N. Hill, Mr. J. S. Hughes, Sir Harold Jeffreys, F.R.S., Dr. E. R. Lapwood, Rev. C. Rey, S.J., Dr. G. D. Robinson, Dr. N. A. Routledge, Mr. H. V. Shaw, Sir Frank Smith, G.C.B., G.B.E., F.R.S.

Section C—Geology

To consider and report on questions affecting the teaching of geology in schools.—Prof. T. N. George (Chairman), Mr. A. Bray (Secretary), Prof. J. G. C. Anderson, Miss M. A. Arber, Prof. W. G. Fearnsides, F.R.S., Dr. J. F. Kirkaldy, Prof. L. R. Moore, Mr. J. Myers, Prof. Sir William Pugh, O.B.E., F.R.S., Dr. K. S. Sandford, Dr. S. H. Straw, Dr. Dighton Thomas, Dr. Mabel E. Tomlinson, Dr. A. K. Wells, Prof. A. Wood.

To excavate critical geological sections in Great Britain.—Mr. W. H. Wilcockson (Chairman), Mr. J. M. Edmonds (Secretary), Prof. P. Allen, Sir Edward Bailey, M.C., F.R.S., Mr. W. S. Bisat, F.R.S., Prof. W. G. Fearnsides, F.R.S., Prof. T. N. George, Prof. H. L. Hawkins, F.R.S., Dr. R. G. S. Hudson, Prof. V. C. Illing, F.R.S., Prof. O. T. Jones, F.R.S., Dr. J. F. Kirkaldy, Dr. Murray Macgregor, Mr. T. G. Miller, Prof. L. R. Moore, Dr. F. J. North, O.B.E., Prof. F. W. Shotton, M.B.E., F.R.S., Prof. F. H. Stewart, Dr. W. E. Swinton, Dr. F. S. Wallis, Prof. D. M. S. Watson, F.R.S., Prof. T. S. Westoll, Prof. W. F. Whittard, F.R.S., Prof. Alwyn Williams, Prof. S. W. Wooldridge, C.B.E.

Sections D,K—Zoology, Botany

Co-ordinating committee for Cytology and Genetics.—Prof. K. Mather, F.R.S. (Chairman), Dr. J. M. Thoday (Secretary), Prof. D. G. Catcheside, F.R.S., Dr. J. L. Crosby, Prof. Sir Ronald Fisher, F.R.S., Prof. P. C. Koller, Dr. P. M. Sheppard.

Section E—Geography

To prepare a glossary of geographical terms with agreed definitions in English, including reference to origin and to current use and misuse.—Prof. L. Dudley Stamp, C.B.E. (Chairman), Mr. G. R. Crone (Secretary), Prof. H. C. Darby, Prof. W. G. East, Mr. E. O. Giffard, M.B.E., Mr. A. F. Martin, Prof. A. A. Miller, Dr. C. J. Robertson, Mr. C. T. Smith, Dr. G. T. Warwick, M.B.E., Prof. S. W. Wooldridge, C.B.E., Mr. R. A. Skelton.

Section H—Anthropology

To explore means for promoting and systematising the study of Ancient Field Systems.—Prof. C. F. C. Hawkes, F.B.A. (Chairman), Mr. H. C. Bowen (Secretary), Mr. A. Aberg, Mr. C. W. Phillips, Mr. G. Whittington, Dr. P. D. Wood. **£10.**

The Council have also agreed to meet the cost of publishing the final report of the Committee appointed to explore means for promoting and systematising the study of ancient field systems.

To carry out research among the Ainu of Japan.—Mrs. Brenda Seligman (Chairman and Secretary), Prof. Daryll Forde, Lord Raglan, Mr. Arthur Waley, C.B.E. **£50.**

To assist in the work of compiling an *Inventaria Archaeologica* as part of an international enterprise sponsored by the International Congress of Prehistoric Sciences.—Prof. E. O. James (Chairman), Dr. D. B. Harden, O.B.E. (Secretary), Prof. C. F. C. Hawkes, F.B.A.

To investigate by experiment the denudation and burial of archaeological structures—Dr. G. W. Dimbleby (Chairman), Dr. P. A. Jewell (Secretary), Prof. R. J. C. Atkinson, Dr. I. W. Cornwall.

The Council report that the remaining £500 of the original bequest of £1,000 from the late Dr. J. E. Crombie had been paid over to the Seismology Committee at the request of the Chairman Dr. R. Stoneley, F.R.S., and with the approval of the General Treasurer.

GENERAL COMMITTEE

The following have been admitted to membership of the General Committee on the recommendation of Section Committees:

Mr. J. R. Atkinson	Mr. M. E. Haine
Prof. S. H. Beaver	Dr. A. Kent
Mr. A. Bray	Mr. H. A. Moisley
Dr. P. W. Brian, F.R.S.	Dr. W. S. McKerrow
Mr. E. R. Davies	Dr. J. McLean
Mr. John Dossor	Mr. N. E. Rowe, C.B.E.
Mr. N. Fairhurst	Prof. A. Salam
Dr. J. L. Harley	Dr. W. A. Sledge

OBITUARY

The Council have during the last year mourned the passing of Prof. Wardlaw, Honorary General Secretary, member of the Council and Past President of Section B (Chemistry); Dr. H. S. Harrison, Past President of Section H and member of Council; Prof. J. Ritchie, Past President of Section D and of the Conference of Delegates; Sir Gilbert Walker, Past President of Section A and member of Council; Sir Claude Gibb, Past President of Section G; Prof. Sir Owen Richardson, Past President of Section A.

They are grieved to report also the untimely death of Dr. W. R. G. Atkins, during his year of office as President of Section K (Botany). Council have suffered further loss by the death of the following office bearers and supporters

Mr. A. H. G. Alston
Mr. A. L. Armstrong
Sir Arthur J. Atkinson
Mrs. J. Bishop
Rt. Hon. Viscount Bledisloe
Mr. J. Brentnall
Miss C. M. Briggs
Miss Caverhill
Mr. D. L. Chapman
Mrs. Hilda Clark
Miss I. M. Crookenden
Dr. C. H. Desch
Hon. Mrs. Grant Duff
Mr. H. H. Fisher
Dr. J. B. Rodney Haines
Miss L. J. Hargreaves
Prof. D. R. Hartree
Dr. J. Jackson
Mr. J. A. Weir Johnston
Dr. K. Jordan
Prof. H. Kroll
Col. G. E. Malcomson
Mr. J. Miller
Mrs. E. M. Neal
Miss E. M. Palmer
Prof. F. A. Paneth
Mr. T. Parkin
Rt. Hon. Lord Eustace Percy
Mr. A. Potter
Prof. J. K. Robertson
Mr. G. A. Steven
Dr. Marie C. Stopes
Mr. J. A. Thomson
Dr. Ruth Turner
Dr. J. A. Venn
Dr. Jessie White
Mr. A. S. Williams

APPENDIX

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REVISION OF THE STATUTES

I. Desiderata

1.

In revising the Statutes, *it is desirable to take into account the new pattern of the Association's activities.* The present Statutes are based on the assumption that the Annual Meeting forms a very high percentage of the total activities of the Association—which has in fact been the case. The Annual Meeting will always be the major single activity, but the percentage of the total which it represents may be expected to vary.

2.

It is desirable that the organisation provided in the Statutes should be simple, streamlined and flexible. Duplication and overlapping should be avoided. Without departing more than is necessary from the traditional, there should be provision for innovation. For example, the development of local inter-meeting activities may very well make it desirable, in very few years, to set up local branches of the Association as local committees are now being set up, and such eventualities should be covered if only by an empowering clause.

3.

It is desirable that the greatest possible freedom should be given to the Association in the exercise of its functions. Principles, and the constitutional skeleton of machinery, should be clearly defined. In general, discretion should be given in matters of practical administration and application of principles either to the Council or to the General Committee. In particular, details of membership and subscriptions should, if it is at all possible, not be stated in the Statutes (thereby requiring approval of the Privy Council for amendment) but should be capable of being fixed and changed by the Association from time to time, provided only that sufficient safeguards are included.

4.

It is desirable that the Statutes should take cognisance of the fact that the financial future of the Association depends upon obtaining a much larger membership based on the new pattern of the Association's activities. This reinforces the argument about freedom in No. 3 above.

5.

In elaboration of No. 2 and No. 3 above, *it is desirable that the power should be conferred upon the Association to make and amend Regulations for the conduct of the Association's business, provided that the Regulations are not repugnant to the Statutes.*

These five general desiderata having been stated, it is possible to examine particular problems and state, in relation to them, desiderata in accordance with the general propositions.

II. Organisation

The present organisation provides for:

The General Committee, as the governing body;
The Council, as the principal executive body;
The Sections, executive for certain purposes;
The Division and its Committee, executive for other purposes, but unable to act in some cases without the specific approval of Council, and lacking financial authority

6.

The General Committee and the Sections are so much part of the tradition and essential fabric of the Association that *it is considered desirable subject to points of detail they should continue much as at present.*

The questions of the Council and the Division are more difficult.

III. The Council

The Council at present consists of *ex officio* members and Ordinary members. The *ex officio* members are again divided into those from the Association proper, and those in connection with host cities for Annual Meetings.

The *ex officio* members from the Association proper are at present:

Past Presidents (of whom a number almost never attend) . . .	13
The President for the year	1
The President for the ensuing Annual Meeting	1
Past General Officers	9
Present General Officers	3
Total . .	27

The *ex officio* members from host cities are:

Vice-Presidents for the ensuing Annual Meeting (of whom there may be a great number, but who almost never attend).

Local Treasurers and Local Secretaries for the Annual Meetings immediately past and ensuing (of whom, generally, only those for the ensuing meeting attend).

The Ordinary Members of Council must not be more than thirty in number, and must include at least two representatives of each Section. Twenty eight are recommended by the Council, and two are elected by the General Committee; but often the General Committee's choice is limited by the requirement that there must be at least two representatives of each Section among the thirty. It should be noted that if another Section is created, in order to satisfy the present Statutes the freedom of the General Committee will disappear entirely, and they will be obliged to elect candidates from certain named Sections.

Attendance at a normal Council meeting is about half total membership, and consists of a number of Ordinary Members, a smaller number of *ex officio* members (some of the Past Presidents never attend) and the Local Treasurer and Local Secretary for the ensuing Annual Meeting. There is thus a fair and reasonable balance between the Officers past and present and the Sections. The membership is also, very properly, almost exclusively scientific.

The new activities of the Association are so much concerned with the presentation of science, however, that there may be a solid advantage to the Association in broadening the basis of the Council without affecting the scientific majority. There are now much closer contacts with industry than heretofore; the new activities and the contributions from industry which have made them possible have led to a much larger budget, and to wider problems of an administrative nature than in the past.

It is felt that the General Committee would wish to have a larger share in deciding the composition of the Council than they in fact have today, and that they would appreciate a free hand in exercising the powers given to them.

It is considered that the present Council is too large really to serve as an effective executive body, and that any increase in membership would accentuate this characteristic.

7.

In accordance with Nos. 1 and 4 above, therefore, *it is desirable that the membership of Council be revised, and if possible reduced.*

It is considered that the President for the year, the President for the ensuing Annual Meeting, Past Presidents (of whom many would not normally attend meetings) and present General Officers should continue to be *ex officio* members. It is considered that past General Officers should not be *ex officio* members, although they would be eligible for election.

It is suggested that Vice-Presidents for the ensuing Annual Meeting need not, as a group, remain members of Council, but that the Chairman and Deputy Chairman of the Local Committee for the current Annual Meeting should, as now, be members of Council.

It is suggested that the representation of Sections should be one per Section, irrespective of the number of Sections, and that each Section should nominate an alternative member, who could attend if the elected representative was unable to attend. The alternative Section representative would also receive full Council papers, and would therefore be aware of the business before Council; and the proposal would ensure that each Section could be represented at every meeting of Council, even if the elected representative was unable to attend. Since the right to send alternative representatives would not be enjoyed by other categories of Council members, this provision would do much to ensure the continuation of the powerful Section representation at normal Council meetings.

It is suggested that the number of members elected by the General Committee each year should be increased from two to a permissive maximum of six—that is, they may elect up to six but need not. This election would be entirely free, with no limitation as to the Sections to be represented; the only requirement would be that persons to be elected to Council should be Members maintaining an annual subscription, or life members.

It is then suggested that the General Officers should be empowered to propose to Council, for recommendation to the General Committee, not more than six additional members. This would enable the appointment to Council of persons of eminence with wide experience in fields of importance to the Association, such as industry, finance and administration.

The membership of the Council would then be:

Past Presidents (of whom a number almost never attend)	13
The President for the year	1
The President for the ensuing Annual Meeting	1
Chairman, Deputy Chairman, Local Secretary and Local Treasurer for the ensuing Annual Meeting	4
Present General Officers	3
Section representatives (probably by the time the new Council came into being)	15
Members elected directly by the General Committee	6
Additional members proposed by the General Officers	6
Total	49

Attendance at a normal Council meeting might be:

Past Presidents	3
The President	1
Local Officers for the ensuing Meeting	3
Present General Officers	2
Section representatives (or alternatives)	15
Members elected by General Committee	3
Additional members proposed by General Officers	3
Total	30

The strength of Sectional representation on Council would thus remain very great.

8.

It is desirable to simplify the present difficult provisions concerning the retirement of members of Council.

It is suggested that this can be done quite simply by providing that all members other than *ex officio* members shall be elected each year by the General Committee. This is in fact the legal position today. There would be one member proposed each year by each Section and recommended by Council to the General Committee. There would be up to six members proposed each year by the General Officers, and recommended by Council to the General Committee. There would be up to six members elected direct each year by the General Committee. The only provision concerning retirement would be the same for all these members, that none should serve for more than five consecutive years, at the end of which period they must stand down, and would not be eligible for re-election in the next ensuing year. (But after an intermission of one year they could be re-elected).

It is suggested that this provision could also be written into the Statutes concerning General Officers, who are also at present appointed each year, and who by custom serve for five years. There is now a resolution of Council to the effect that General Officers should ordinarily vacate office after five years, but that the period could be extended to a maximum of seven years.

IV. The Division

If the Council is reinforced in this way, what then becomes the position of the Division?

The Division has served the Association well in the past twenty years. It ensured the continuation of the Association's activities during the second world war. It has staged valuable discussions and conferences. It has been the means of introducing to the work of the Association a number of extremely valuable persons of the type envisaged for the proposed additional members of Council. It has provided an umbrella under which the new activities of the Association could be initiated, when nothing else in the Statutes permitted that to be done which has been done.

It suffers however from major disabilities as an executive organisation. If it arranges a Conference, it must have the specific approval of Council (Statutes, Chapter I, para. 4, and Chapter VII, para. 3 (i)). For its other functions (Statutes, Chapter VII, para. 3 (ii) to (vi)), it disposes of no funds. If it does set up a Sub-Committee (such as an Area Committee) it must apply to Council for a grant to enable the sub-committee to work.

In the past eighteen months, the new activities have been undertaken under the auspices of the Division, and what has been done has been reported to the Committee of the Division. But since so many of the proposals have required financial provision, and in view of the difficulty of arranging meetings of the Committee of the Division, many of the decisions have in fact been taken directly by the Council, or by the Finance and General Purposes Committee in the name of the Council. As a result, the number of meetings of the Committee of the Division has been less than it should have been for the body ostensibly responsible for the new activities.

The present provisions of Chapter VII of the Statutes are only partially satisfactory as a temporary 'umbrella' for the activities now being undertaken under the auspices of the Division.

Nothing that the Division can do now, or could do if it were given greater powers, could not be done equally well by the Council, if it were given powers. It is recalled that the development of some new activities, particularly Area Committees, may well lead to proposals which would affect the fabric of the Association, such as the formation of Branches of the Association, with provision for their constitution and the conduct of their affairs; and these would have to be the concern of the Council, and probably of the General Committee.

At the same time, there is no doubt that the considerations which led to the formation of the Division are as valid today as twenty years ago, in spite of, or perhaps because of, the great development in the social and international relations of science; and whatever

decision may be reached on the organisation to deal with these problems, it is desirable that the purposes of the Division, stated in para. 1 of Chapter VII, should be restated in the new statutes in an appropriate context.

It is recalled that the question is what provision is to be made in the Statutes. It seems that there are three possible courses of action:

(1) To retain the Division, and Chapter VII of the Statutes, much in the present form, while making provision for Area Committees and other new activities, including the possible creation of Branches of the Association, to be dealt with by Council. This would leave the Division in the position which it occupied before the new activities started after the Dublin meeting.

(2) To retain the Division, and recast Chapter VII completely so as to make provision for Area Committees and the Young People's Programme, and to give the Division greater executive and financial power to deal with these matters.

(3) To abolish the Division as such, and provide in the Statutes for the Council to have all the necessary powers, including the power to establish Branches (perhaps subject to approval by the General Committee) and to make regulations for these matters. In this case the purposes of the Division could be restated among the Objects of the Association, so that it would be the responsibility of the Council to give effect to them.

It is suggested that desiderata which have already been stated point to the answer. The avoidance of duplication suggests that if the principal executive body of the Association is anyhow to meet regularly, it is reasonable that it should deal with all the affairs of the Association. Flexibility suggests that it is undesirable to prescribe in the Statutes a second body, when rapidly changing circumstances make it difficult to foresee the future relationship between the two. Provided therefore that the purposes of the Division are specifically stated among the objects of the Association in the new statutes, it is suggested that practical considerations are in favour of (3) above.

9.

It is suggested as desirable that the Division as such should cease to exist; that its powers and functions should be taken over by Council, which would then have control over all the Association's activities except the specific activities of the Sections; and that the purposes of the Division should be restated in the Objects of the Association.

V. Membership

Membership has already been touched upon in Desiderata 3 and 4 above. The matter is difficult, because so many factors are involved. It could also be decisive for the future of the Association.

The time factor is most important. It is hoped that new Statutes may be ready for consideration by the General Committee at York this year. If they are, and are agreed, it is hoped that they would be approved by the Privy Council before the 1960 meeting at Cardiff.

It will however only be possible to have new Statutes ready for consideration by the General Committee at York if they do in fact provide for the Association to be given the power to fix and vary terms of membership and subscriptions without further amendment to the Statutes. If this is not possible (because the Privy Council would not approve it), then the new Statutes will have to include the new proposals for membership and subscriptions in detail, and certainly they could not be ready for York.

In elaboration of No. 4, it is possible to state two basic considerations:

10.

It is desirable to increase the revenue accruing to the Association.

11.

It is desirable not to do anything that would discourage people on grounds of expense from attending the Annual Meeting.

These basic considerations are to some extent conflicting, and finding the correct balance between them is not easy.

At present the full member pays £3 3*s*. 0*d*. (with the right for those who pay income tax at full rate to covenant for seven years at £2 2*s*. 0*d*.) and for this he attends the Annual Meeting (or may do so) and receives the Journal. Associate members pay £2 2*s*. 0*d*. (with the right for those who pay income tax at full rate to covenant for seven years for £1 1*s*. 0*d*.) and for this they may *either* attend the Annual Meeting *or* receive the Journal.

A new service, which we hope will start next autumn in those places where there is an Area Committee, is programmes of local lectures for members only; and members should, it is considered, be entitled as of right to attend other lectures arranged locally by the Association. By the time the new Statutes come into force, it is hoped that this new service will be fairly well developed.

Various devices have been considered for increasing revenue by increasing subscriptions, either openly or by less direct means which would nevertheless have the effect of asking members to pay more. All these devices conflict with No. 11 above, and may also suffer from the law of diminishing returns. The last time subscriptions were increased, the additional revenue was less than half what, arithmetically, it might have been expected to be. If the law operated again, it might well frustrate the very large increase in membership which might otherwise result from new activities.

12.

It is desirable that membership should increase, as well as revenue. A buoyant and growing membership would be the best possible evidence to industry, which has provided the funds for the new activities, of the success of the programme, and would do much to secure continued support from industry in a manner which is described below.

After careful consideration of the many possibilities, it is felt to be undesirable to make specific proposals at the moment for changes in membership subscriptions. Such changes as may become necessary will depend, amongst other things, upon the planned development of Area Committees into regional branches of the Association. This process of growth will make it necessary to re-consider the whole membership structure. Changes in the terms of membership will necessarily be related also to the success which attends the new Journal now proposed by the Editorial Committee. It is felt that time should be allowed for the effect of changes in style and frequency of publication to show itself.

It was agreed to recommend that when the Statutes are revised, the Privy Council should be asked to approve a Statute giving the Council, subject to the approval of the General Committee, power to determine by regulation the classes and rates of subscription from time to time. It was also recommended that such a Statute should include suitable provision for Corporate and Life members.

SUMMARY OF RECOMMENDATIONS

1. The General Committee and Sectional Committees should remain as at present.

2. *Council*

(*a*) *Composition*

It is recommended that the Council should consist of the following Officers:

(i) The President for the year.
(ii) The President for the ensuing Annual Meeting.
(iii) Past Presidents.
(iv) General Officers.

(v) The Chairman and Deputy Chairman of the Local Committee and the Local Honorary Secretaries and Local Honorary Treasurer for the current Annual Meeting.
(vi) One representative of each Section (with an alternate in each case).
(vii) Not more than six members elected by the General Committee.
(viii) Not more than six members proposed by the General Officers and nominated by the Council.

(*b*) *Retirement of Members*

It is recommended that the provisions concerning the retirement of Council be simplified by providing that all members, other than *ex officio* members, shall be elected each year by the General Committee, and that no member shall serve for more than five consecutive years.

3. *The Division for the Social and International Relations of Science*

It is recommended that the Division as such should cease to exist; that its powers and functions should be taken over by the Council; and that the purposes of the Division should be re-stated in the Objects of the Association.

4. *Membership and Subscriptions*

It is recommended that when the Statutes are revised, the Privy Council should be asked to approve a Statute giving the Council, subject to the approval of the General Committee, power to determine by regulation the classes and rates of subscription from time to time. It is also recommended that such a Statute should include suitable provision for Corporate and Life members.

YORK MEETING
SECTIONAL TRANSACTIONS

Any references to publication supplied by authors will be found in the list below. References indicated by 'Cf.' are to appropriate works quoted by the authors of papers, not to the papers themselves.

SECTION A
MATHEMATICS AND PHYSICS

Thursday, September 3

PRESIDENTIAL ADDRESS by Professor L. F. Bates, F.R.S., on *The visualisation of magnetic processes.*
(Lancashire-Spencer Professor of Physics, Nottingham U.)

Ferrimagnetism:

Mr. A. C. Lynch.—*Ferrimagnetic materials.*

Four groups of non-metallic magnetic materials are now known; because they are insulators they can be used, both in research and in engineering, at high frequencies. Their characteristic properties show that within each molecule the magnetic movements are, in part, mutually opposed.

(S.P.S.O., Post Office Engineering Research Station.)

Cf. 'The Magnetic properties of ferrites', *Science Progress*, **45**, 210 (1957); *Annual Science Survey* (Hulton Press, 1960).

Dr. G. E. Bacon.—*Antiferromagnetism and how it can be studied with neutron beams.*

When a beam of neutrons falls on 'magnetic' atoms more neutrons are scattered aside than for 'ordinary' atoms. A study of their angular distribution from antiferromagnetic materials identifies the tiny magnets on each atom, showing them to be lined up in pairs, up and down, parallel to a single direction.

(Senior Principal Scientist and Head of Neutron Diffraction Group, A.E.R.E., Harwell.)

Friday, September 4

THE KELVIN LECTURE by Dr. S. Brenner on *Building Viruses.*
(Member M.R.C. Unit for Molecular Biology, Cavendish Laboratory, Cambridge.)

Radiocarbon dating (*Joint session with Section H (Anthropology)*).

To appear in *Nature.*

Mr. H. Barker.—*Radiocarbon dating—its scope and limitations.*

This paper reviews recent advances in dating techniques with particular reference to radiocarbon dating. During the past decade, the radiocarbon method has provided extremely valuable information in many archaeological investigations. Unfortunately its full capabilities and limitations are often not completely understood due to the lack of common ground between the disciplines of physics and archaeology. It is hoped that this communication will help to resolve some of these difficulties.

(Senior Experimental Officer, Research Laboratory, British Museum).

Cf. *Antiquity*, **XXXII**, 253–63 (1958).

Mr. W. J. Callow.—*Radiocarbon dating at the National Physical Laboratory.*

Factors affecting the choice of the techniques employed and the design of the apparatus will be covered and an assessment made of the accuracy and limitations of the method.

(P.S.O., N.P.L., Teddington.)

Dr. H. Godwin and Dr. E. A. Wilson.—*Cambridge radiocarbon dates for the late Quaternary Period.*
(Botany School, Cambridge).

Monday, September 7

Microseisms and storms:

Dr. J. Darbyshire.—*Storms and microseisms.*

Microseisms result from ground waves formed at the sea bottom by sea waves in a fast-moving storm. They can be recorded by seismographs on land and provide useful information about the storm, such as its bearing and the strength of the wind. Microseisms can be of great use in weather forecasting in sea areas.

(P.S.O., National Institute of Oceanography.)

To appear in *Times Science Review*.

Cf. *Proc. Roy. Soc. A*, **202,** 439 (1950); *Proc. Roy. Soc. A.*, **223,** 96 (1954); *Mon. Not. R. Astr. Soc. Geophys. Suppl.* **7,** 147 (1955); *Mon. Not. R. Astr. Soc. Geophys. Suppl.* **7,** 301 (with M. Darbyshire) (1957); H. M. Iyer & J. Darbyshire, *New Scientist*, **3,** 16–18 (1958).

Crystal physics:

Prof. G. F. J. Garlick.—*Electrons in crystals.*

The close approach of atoms to each other in crystals strongly disturbs their electronic energy states and properties. A largely non-mathematical approach to the problem can be made and the apparently unusual properties of electronics in metals, insulators and semiconductors explained and their practical importance discussed.

(Head of Department of Physics, Hull U.)

Dr. Erich E. Schneider and Dr. R. V. Hesketh (read by the latter) —*Coloured crystals as model solids.*

The characteristic discolorations of simple crystals such as rocksalt produced by ionising radiation or additive methods provide a visible manifestation of electronic energy states associated with crystal imperfections, allowing direct experimental demonstrations of electronic conduction phenomena as well as model experiments illustrating the mechanism of radiation damage and plastic deformation.

(Physics Dept., King's College, Durham U.)

Tuesday, September 8

Radiation damage:

Dr. W. M. Lomer.—*Radiation damage and atomic displacements in crystals.*

Bombardment of solid materials by fast charged particles and neutrons changes many of their important properties. Even though a comparatively small proportion of the atoms are moved from their normal positions, considerable interference with the normal mechanisms of plastic flow is possible. After long irradiation the damage may accumulate so that the energy stored is considerable.

(Deputy Chief Scientist, Head of Theoretical Physics division, A.E.R.E., Harwell.)

Cf. A. H. Cottrell, J. C. Bell, G. B. Greenough, W. M. Lomer & J. H. W. Simmons, 'Theory of annealing kinetics applied to the release of stored energy from irradiated graphite in air-cooled reactors', Paper No. 2485, *Second United Nations International Conference on the peaceful uses of atomic energy* (Geneva, 1958); J. L. Dickson, G. H. Kinchin, R. F. Jackson, W. M. Lomer & J. H. W. Simmons, 'Bepo Wigner energy release', Paper No. 1805, *Second United Nations International Conference on the peaceful uses of atomic energy* (Geneva, 1958).

Prof. A. Charlesby.—*Effects of atomic radiation on molecular structure.* (Read by Mr. C. Grace.)

Exposure to atomic radiation can promote useful changes in certain materials and this process is now being used commercially. Detailed studies of the processes involved, and methods of modifying them, provide a deeper insight into the interaction of radiation and matter and may result in new materials of practical value.

(Dept. of Physics, Royal Military College of Science, Shrivenham.)

Prof. W. V. Mayneord, Dr. R. C. Turner, Dr. J. M. Radley.—*Origin and metabolism of radio-active materials in the human body.*
(Read by Dr. R. C. Turner.)

The relative contributions made by food and water to the radio-activity of the human body are presented, together with a discussion of the probable metabolic fate of certain of the radio-active substances concerned.

(Prof. Mayneord is Professor of Physics, British Post-graduate Medical Federation; Dr. Turner and Dr. Radley are Assistant Physicists, Department of Physics, Institute of Cancer Research.)

Prof. F. W. Spiers.—*Ionizing radiation in the environment.*

Consideration will be given to the natural sources of ionizing radiation in the environment and the contribution they make to the radiation dose to which humans are exposed. Results of surveys in this and other countries will be used to illustrate the range of dose rates, as now known, and additional radiations from man-made sources will be related to the natural levels.

(Professor of Medical Physics, Leeds U.)

Wednesday, September 9

Novel techniques:

Mr. L. King.—*The transfer of material in high-current arc discharges.*

A discussion of the jets observed in the high-current electric arc on the basis of a theory of dissociation and ionization showing that these jets account for the material transported in the welding arc. (Illustrated by film.)

(Senior Research Physicist, Electrical Research Association.)

Dr. N. W. Robinson.—*Ultra-high vacua.*

Recent advances in ultra-high vacuum techniques are described, showing how pressures approaching those in outer space may be obtained and measured in the laboratory. The diffusion of gases from solids and their absorption and desorption at surfaces are the dominant factors in the maintenance of ultra-high vacua.

(Research Physicist, Mullard Research Laboratory.)

Cf. 'Some vacuum problems in the valve industry', *Vacuum*, **6**, (1956), pub. 1959, 21–40; 'All metal bakeable taps' to appear in *Electronic Engineering;* with F. Berz, 'Initial pumping and recovery of ionisation gauges', *Vacuum*, **9**, (1959).

Dr. J. M. Lock.—*Cryotrons: high-speed superconducting computer devices.*

The superconducting switch known as the 'cryotron', invented by D. A. Buck in 1953, will be described and its limitations discussed. An account will be given of subsequent progress towards higher speed superconducting devices, paying particular attention to the information storage element described by J. W. Crowe in 1957, capable of switching in 10 millimicroseconds.

(P.S.O., Royal Radar Establishment, Malvern.)

SUB-SECTION A*
MATHEMATICS

Friday, September 4

Topology:

Dr. E. M. Patterson.—*Basic ideas in topology.*

Basically topology is a study of properties of figures which are unaffected when the figures are deformed continuously without breaks or joins. Some of the early problems in topology, and the influence of one of them on the development of modern Pure Mathematics, will be discussed.

(Lecturer in Pure Mathematics, Leeds U.)

Dr. S. Wylie.—*The topology of three-dimensional manifolds.*

The problem of the classification of three-dimensional manifolds was one of the main challenges to topologists twenty-five years ago. It is only recently that any substantial contributions have been made towards it. This communication is intended to describe the problem and to give some account of its present state.

(D.C.S.O., Scientific Civil Service.)

Dr. K. F. Roth.—*Irrational numbers.*

Any real number (rational or irrational) has infinitely many distinct rational approximations h/q differing from it by not more than 1/q. Irrational numbers alone have rational approximations which are essentially more accurate. The degree of accuracy attainable varies with the irrational number considered, and is of the greatest importance in the study and classification of irrational numbers.

(Reader in Mathematics, U.C.L.)

Monday, September 7

Analysis of space flight:

Mr. D. G. King-Hele.—*Results obtained from the study of satellite orbits.*

The main perturbations to satellite orbits are due to the earth's oblateness and the atmosphere. By comparing the observed perturbations with theory, it has been possible to find out a good deal more about the figure of the earth, the average air density at great heights, and the variations in air density.

(P.S.O. R.A.E., Farnborough.)

Cf. *Annual Science Survey* (Hulton Press, 1960); 'Density of the atmosphere at heights between 200 and 400 km., from analysis of artificial satellite orbits', *Nature*, **183,** 1224–7 (1959); 'The effect of the earth's oblateness on the orbit of a Near Satellite, *Proc. Roy. Soc. A*, **247,** 49–72 (1958); 'Perturbations of the orbit of a satellite near to the earth, *Proc. Roy. Soc. A*, **248,** 55–62 (1958); 'The descent of an earth satellite through the upper atmosphere', *J. British Interplanetary Society*, **15,** 314–23 (1956); D. G. King-Hele & D. C. M. Leslie, 'Effect of air drag on the orbit of the Russian earth satellite 1957 beta: Comparison of theory and observation', *Nature*, **181,** 1761–63 (1958); D. G. King-Hele & R. H. Merson, 'A new value for the earth's flattening derived from measurements of satellite orbits', *Nature*, **183,** 881–2 (1959); D. G. King-Hele & R. H. Merson, 'Satellite Orbits in Theory and Practice', *J. British Interplanetary Society*, **16,** 446–71 (1958); D. G. King-Hele & Mrs. D. M. C. Walker, 'The last minutes of Satellite 1957 beta (Sputnik 2)', *Nature*, **182,** 426–7 (1958); D. G. King-Hele & Mrs. D. M. C. Walker, 'Irregularities in the Density of the Upper Atmosphere: Results from Satellites', *Nature*, **183,** 527–9 (1959); R. H. Merson & D. G. King-Hele, 'Use of Artificial Satellites to explore the earth's gravitational field: Results from Sputnik 2 (1957 beta)', *Nature*, **182,** 640–1 (1958); R. H. Merson, D. G. King-Hele & R. N. A. Plimmer, 'Changes in the Inclination of Satellite Orbits to the Equator', *Nature*, **183,** 239–40 (1959).

Dr. A. H. Cook.—*The figure of the earth and the orbits of artificial satellites.*

The relation between the shape of the earth and its external gravity field, principal features of the orbit of an artificial satellite, new results from satellite observations, their significance and extensions needed to the theory of the earth's gravity field.

(P.S.O., Standards Division, N.P.L.)

Dr. P. T. Matthews.—*Elementary particles—the basic stuff of the universe.*

A rapid historical survey of man's notions on the structure of matter, leading up to modern nuclear theory and the sixteen elementary particles—hyperons, nucleons, mesons and leptons—out of which all matter (energy) is apparently made. A discussion of the properties and significance of these elementary particles.

(Reader in Mathematical Physics, Imperial College, London.)

SECTION B

CHEMISTRY

Thursday, September 3

PRESIDENTIAL ADDRESS by Prof. M. Stacey, F.R.S., on *Medical applications of complex carbohydrates.*

Comments will be made on present ideas of the structure of complex carbohydrates which are known as polysaccharides.

Their significance in infectious diseases and immunity, in fevers, in carbohydrate storage, in blood coagulation and blood grouping, etc., will be discussed.

(Mason Professor and Head of Department of Chemistry, Birmingham U.).

Prof. S. Laland.—*The carbohydrate components of nucleic acids.*

The present knowledge of the carbohydrate components of nucleic acids will be described. Methods for detecting and isolating these carbohydrates, as well as their phosphates, in particular those linked to the pyrimidine bases, will be discussed.

(Professor of Biochemistry at the University of Oslo.)

Cf. L. Haavaldsen, S. Laland, J. McKinley McKee & E. Roth, 'Isolation and estimation of the sugar of pyrimidine nucleosides and nucleotides after reduction', *Biochim. Biophys. Acta*, **33**, (1959); S. G. Laland & W. G. Overend, 'Isolation of 2-Deoxy-D-ribose from Deoxypentosenucleic Acids', *Acta Chem. Scand.* **8**, 192–8 (1954); A. S. Jones & S. G. Laland, 'Sugar component of Deoxypentosenucleic Acid from *Mycobacterium phlei*', *Acta Chem. Scand.* **8**, No. 4 (1954).

Prof. J. Baddiley.—*The bacterial cell wall.*

Bacterial walls are structurally and chemically distinct from the cell itself. The chemical composition of the wall, and in particular a new group of natural polymers, teichoic acids, will be described. Views on the mechanism of action of penicillin and other inhibitors will be discussed in relation to their known effect on bacterial walls.

(Professor of Organic Chemistry, King's College, Durham U., Newcastle upon Tyne.)

To appear in *Annual Science Survey* (Hulton Press, 1960).

Cf. Tilden Lecture, 'Nucleotides and bacterial cell wall components', *Proc. Chem. Soc.* 1959, 177; J. J. Armstrong, J. Baddiley, J. G. Buchanan, A. L. Davison, M. V. Kelemen & F. C. Neuhaus, 'Teichoic acids from bacterial walls', *Nature*, 247 (1959).

Friday, September 4

Proteins:

Dr. G. T. Young—*The synthesis and degradation of peptides.*

The lectures will deal with the laboratory synthesis of peptides from α-amino-acid units and the degradation of peptides for the determination of the sequence of the amino-acid residues.

(Fellow, Jesus College, Oxford.)

Cf. 'Amino-acids and peptides', *J. Chem. Soc.* (1950 onwards); *Annual Reports on the progress of Chemistry, 1957* (1958).

Professor H. D. Springall.—*The molecular structure of* (*a*) *proteins,* (*b*) *nucleo-proteins.*

The lectures will outline how the classical pattern of natural product investigation:—Isolation: Proof of purity: Molecular weight determination: Analysis: Degradation: Synthesis: has been applied to proteins and nucleoproteins.

(Professor of Chemistry, Univ. College of N. Staffordshire.)

Monday, September 7

Chemistry and clothing:

Mr. W. H. Rees.—*Some physical aspects of clothing for comfort.*

The function of textile fabrics of various types in the maintenance of body comfort under conditions of exposure to external cold and to incident high temperature radiation.

(Senior Research Officer at the Shirley Institute, Manchester.)

Cf. 'The protective value of clothing', *J. Text. Inst.* **37**, 132 (1946).

Prof. C. S. Whewell.—*The chemical treatment of apparel fabrics.*

A discussion of the chemical treatment of textiles to improve their usefulness as clothing materials, special attention being given to the following topics: the prevention of shrinkage; durable pleating; 'drip-dry' and 'minimum care'

fabrics; the production of washable outerwear; waterproofing; fireproofing; mothproofing; resistance to creasing.

(Professor of Textile Technology, Leeds U.)

Mr. A. B. Thompson.—*The modern synthetic fibres.*

The development of the modern synthetic fibres and their functional performance in clothing.

(Fibres Division, ICI Ltd.)

Dr. H. A. Thomas.—*Advances in clothing technology by the use of fibre blends and yarn mixtures.*

The paper will deal with the contribution of man-made fibres to developments in apparel fabrics with particular reference to blends and mixtures containing hydrophilic fibres used in conjunction with hydrophobic and/or natural fibres. The technology of blending, dyeing and performance testing will be described. Reference will also be made to properties, construction and end uses, including protective clothing.

(Marketing Manager (Technical), Courtaulds Ltd.)

Tuesday, September 8

Rocket propulsion:

Dr. W. B. Littler, C.B.—*Introduction.*

(Director-General of Scientific Research (Munitions), Ministry of Supply.)

Mr. G. K. Adams.—*Thermodynamic aspects of the choice of rocket propellants.*

The performance limitations and efficiency of energy conversion in rockets based on chemical systems will be discussed.

(Superintendent, Ministry of Supply Explosives Research and Development Establishment, Waltham Abbey.)

Mr. J. E. P. Dunning.—*The application of liquid propellants to rockets.*

A description of the principal features of liquid propellant rockets will be given. The advantages and disadvantages of liquid propellants for various applications will be discussed.

(Director, Ministry of Supply Rocket Propulsion Establishment.)

Dr. G. H. S. Young.—*The application of solid propellants to rockets.*

A description of types of solid propellant, especially those of British origin, will be given. Burning rates and performance will be discussed and manufacturing processes described briefly.

(Superintendent, Ministry of Supply Explosives Research and Development Establishment, Waltham Abbey.)

Dr. L. R. Shepherd.—*Propulsion in space.*

To meet the requirements of propulsion in outer space, rocket engines having greater propulsive energy than conventional chemical systems are required; these will be discussed.

(Physicist in the Research Group of the U.K.A.E.A.)

Wednesday, September 9

Chemistry in the preservation of antiquities:

To appear in *Nature*.

Dr. A. E. A. Werner.—*New methods in conservation of antiquities.*

The use of new synthetic materials in the conservation of antiquities of an organic nature will be described, including synthetic waxes for the treatment of waterlogged wood, epoxy resins as consolidants for worm-eaten wooden objects and soluble nylon for treatment of ostraka and flaking paint on wall paintings and illuminated manuscripts.

(Keeper, Research Laboratory, British Museum.)

Cf. 'Technical notes on a new material in conservation', *Chronique d'Egypte*, **XXXIII**, 273–8 (1958); 'Synthetic waxes', *Museums J.* **57**, 3–5 (1957).

Mr. R. M. Organ.—*The conservational treatment of corroded metallic antiquities.*

A museum has the duty of preserving for posterity the whole study-potential of an object which may be in an unstable condition. Scientific methods of examination lead to the devising and application of chemical and physical treatments to stabilise an antiquity in as nearly its original condition as possible.

(Senior Experimental Officer, Research Laboratory, British Museum.)

Cf. 'The washing of treated bronzes', *Museums J.* **55,** 112–19 (1955); 'Treatment using ultra-sovic vibrations', *Studies in Conservation,* **4,** 35–7, (1959); 'The treatment of the St. Ninian's Hanging Bowl Complex', *Studies in Conservation,* **4,** 41–50 (1959).

SECTION C
GEOLOGY

Thursday, September 3

Prof. H. C. Versey.—*Geology of the district around York.*

(Professor of Geology, Leeds U.)

Mr. Wilfrid N. Edwards.—*The Pleistocene glaciation of Yorkshire.*

Description of Older and Newer Drift, the former dissected, the latter fresh and associated with periglacial deposits. The main Older Drift passed south into the Midlands; that of the Newer Drift (in two stages) was halted near York. Correlation is suggested with other areas.

(Geological Survey: Assistant Director Northern England.)

Friday, September 4

Age and sedimentation of the Yoredales:

Prof. K. C. Dunham, F.R.S.—*The problems of the Yoredales.*

The Yoredale Series, originally defined by John Phillips (1836), is now known to represent a diachronous facies characterised by well-developed rhythmic sedimentation. A review is given of the problems of correlation and sedimentation presented by the facies, and methods by which these may be attacked are suggested.

(Professor of Geology, Durham U.)

Mr. W. S. Bisat, F.R.S.—*The goniatite succession in the Yoredales.*

Occasional goniatites occur in the Yoredale Series. These suggest that the Hardraw shales are of P_1b to P_1c age, and that the junction of P_1 and P_2 is about the top of the Middle Limestone. The top of the Visean is probably about the horizon of the Three Yard Limestone.

Dr. G. A. L. Johnson.—*Age and lateral variation of the Carboniferous Yoredale deposits of northern England.*

New work on the Carboniferous cyclothemic Yoredale Series of northern England has proved the age of the succession and the correlation of the sequence from the Craven country, Yorkshire, to north Northumberland is now more definite. Considerable lateral variation of the deposits is present in this region.

(Tutor and Lecturer, Dept. of Geology, Durham U.)

Cf. 'Carboniferous stratigraphy of the Roman Wall district in western Northumberland', *Proc. Yorks. Geol. Soc.* **32,** 83–120, pl. 2 (1959); 'Lateral variation of marine and deltaic deposits with particular reference to Visean and Namurian of northern England', *Report of 4th Congress on Carboniferous stratigraphy and Geology, Heerlen, Sept. 1958,* (in press); *Report of XXI International Geological Congress in Denmark* (end 1960).

Dr. R. G. S. Hudson.—*The sedimentation of the Yoredales.*

The relation of the Yoredale Series to the Bowland shales is discussed and a correlation of synorogenic movements as evidenced by sedimentation breaks within the two groups is attempted.

(Research Associate, Dept. of Geology, U.C.L.)

Monday, September 7

PRESIDENTIAL ADDRESS by Prof. O. M. B. Bulman, F.R.S., on *Recent developments and trends in palaeontology*.

(Woodwardian Professor of Geology, Cambridge U.)

Microseisms and storms (*see entry under Section A* (*Mathematics and Physics*)).

Dr. K. A. Joysey.—*The evolution of* Gryphaea incurva—*a reconsideration of the evidence.*

The coiled Jurassic oyster *Gryphaea incurva* is classic in evolutionary literature and has influenced many discussions on recapitulation, orthogenesis and the species concept. Subsequent to the pioneer studies by Trueman and Swinnerton statistical methods have evolved. It now becomes necessary to review the evidence and some of the original conclusions.

(Assistant Curator, University Museum of Zoology, Cambridge.)

To appear under title, 'The evolution of the Liassic oysters *Ostrea-Gryphaea*', *Biol. Rev.* **34**, 297–332.

Dr. M. J. S. Rudwick.—*A functional reconstruction of a peculiar Permian brachiopod.*

The very peculiar shells of *Prorichthofenia* have been studied to try to reconstruct the way that the animal lived when it was alive. Its structure suggests that it had a very unusual way of feeding. This is supported by observations on a working model of the shell.

(Demonstrator in Geology, Cambridge U. Research Fellow in Palaeontology, Trinity College, Cambridge.)

Glacial geology:

Prof. T. N. George.—*Glen Roy and its regional setting.*
(Dept. of Geology, Glasgow U.)

Dr. D. A. Bassett.— *The glacial sediments of Glen Roy.*
(Dept. of Geology, Glasgow U.)

Dr. D. W. Powell.—*Geophysical surveying at Glen Roy.*
(Dept. of Geology, Glasgow U.)

Mr. K. W. Brown.—*Pro-glacial drainage in East Cleveland.*

A study of the marginal drainage associated with the last ice-sheet, between Girrick and Ugthorpe Moors. Stages in retreat, indicated by the channel sequences are correlated with the pattern of moraine development.

Tuesday, September 8

Mr. R. G. W. Brunstrom.—*Structure and stratigraphy of the East Midlands oilfields.*

There are nine oilfields in the East Midlands, all with oil in rocks of Carboniferous age. The oilfields occupy anticlinal culminations which are concealed beneath flay-lying rocks, and some also have oil in lensing sands downflank. Plungar oilfield lies beneath basic igneous rock which replaces Coal Measures laterally.

(Exploration geologist, B.P. Exploration Co. Ltd.)

Cf. C. M. Adcock, R. G. W. Brunstrom, K. H. Roberts & H. R. Warman, 'Report on oil and gas in the U.K.', *Symposium Sobre Yacimientos de Petroleo y Gas*, V, *Europa*, 317–57 (XX International Geological Congress, Mexico, 1956).

Mr. J. W. Neale.— *Yorkshire Lower Cretaceous stratigraphy.*

Stratigraphic problems of the Speeton Clay both at outcrops and in adjacent boreholes are outlined and some preliminary results of a palaeo-ecological investigation of the lower beds are given.

(Lecturer in Geology, Hull U.).

Wednesday, September 9

Prof. York T. Mandra.—*The present status of Silicoflagellates.*

Silicoflagellates are microscopic (10 to 100 microns in diameter), unicellular, marine flagellates which are widely distributed in the plankton of present oceans. Studies of fossil silicoflagellates suggest that these organisms can be used for detailed stratigraphic zonation and for intercontinental correlations. Statistical analyses of recent silicoflagellate faunas have led to a technique which will indicate near surface temperatures of Cenozic marine waters.

(Head of Geology Dept., San Francisco State College, U.S.A.)

Mr. A. W. Read.—*The Bannockburn Main Coal—a study in lateral variation.*

The Bannockburn Main Coal of the Stirling Coalfield varies, within 4 miles, from one seam 30 in. thick to a complex of strata over 80 ft. thick which includes fifteen coals. The factors causing this local variation include differential compaction; they seem to be superimposed on those that control cyclic sedimentation.

(Senior geologist, Geological Survey of Great Britain, Edinburgh.)

Expected to appear in *Trans. Edin. Geol. Soc.*

Cf. *Coalfield Papers of Geol. Survey of Great Britain, No. 2* 'The economic geology of the Stirling and Clackmannan Coalfield Scotland. Area south of the River Forth' (end 1959).

Mr. M. P. Atherton.—*Almandine and Biotite in Dalradian type metamorphism.*

A consideration of the variation in composition of co-existing ferromagnesian minerals with increased grade, related to their paragenesis, the metamorphic rocks of Perthshire and Co. Mayo.

(Research Student, Geology Dept., Sheffield U.)

SECTION D

ZOOLOGY

Thursday, September 3

PRESIDENTIAL ADDRESS by Dr. L. Harrison Matthews, F.R.S., *Man and the world fauna.*

(Director and Permanent Secretary, The Zoological Society of London.)

Harvesting the seas:

Mr. B. B. Parrish.—*Problems concerning the herring fisheries in the North Sea.*

The history of the growth of the North Sea herring fisheries will be described, with special reference to the striking changes in the method of capture and in the types of exploitation. Attention will then be focused on the major changes in the composition and size of catches from the post-war fisheries, and these will be examined in the light of modern population theory.

(Scottish Home Department, Marine Laboratory, Aberdeen.)

Mr. R. J. H. Beverton.—*Fishery research in the Arctic.*

An account of the development of arctic fisheries, and of the lines of research carried out by England and Russia on immature cod and by Norway on spawning stock. There will be a discussion of the effect of water movements and temperature on distribution and migrations of cod and haddock, of the dynamics of the arctic cod population, and of the regulation of the arctic fisheries.

(Deputy Director of Fishery Research, Fisheries Laboratory, Lowestoft.)

Marine aquaria:

Dr. D. P. Wilson.—*Public marine aquaria.*

A brief historical account of the public aquarium during the last hundred years. Good and bad features in aquarium design. The old aquarium at the

Plymouth Marine Laboratory and a description of the new one completed this year. Some breeding and other habits observed in the aquarium.

(Zoologist, Marine Biological Laboratory, Plymouth.)

Cf. 'The aquarium and sea-water circulation system at the Plymouth laboratory', *J. Mar. Biol. Ass.* **31,** 193–212.

Dr. H. G. Vevers, M.B.E.—*A public aquarium is not a fish-house.*

Public aquaria have only existed for about a hundred years. For much of this period they have exhibited little more than tankfuls of fish, thus missing great opportunities to show the wealth of plant and invertebrate life of the sea and fresh waters. A public aquarium should contain a representative collection of all aquatic life.

(Curator of the Aquarium, The Zoological Society of London.)

Dr. L. J. Hale.—*Marine aquaria in the laboratory.*

The essential structural and biological features of a successful type of marine aquarium will be discussed. In such an aquarium a wide variety of animals have lived successfully in the same unfiltered sea-water. The water is circulated relatively rapidly by a simple trouble-free pump.

(Dept. of Zoology, Edinburgh U.)

Friday, September 4

Animal clocks:

To appear in *Nature.*

Prof. F. A. Brown, Jr.—*Environmental timing of persistent daily, lunar and annual rhythms.*

Recent research is described which establishes that living things continue to exhibit environmentally-imposed daily, lunar and annual periodisms even in conditions hitherto presumed to be constant. It is postulated that such periodisms comprise the basic 'biological clocks', and the well-known characteristics of persistent rhythms are shown to be readily interpretable in these terms.

(Morrison Professor of Biology, Northwestern U., U.S.A.)

To appear in *Science* (American Association for the Advancement of Science, Washington, D.C., U.S.A.).

Dr. A. J. Haddow.—*The influence of the environment on the cyclical biting behaviour of mosquitoes.*

Most mosquito species have regular diurnal cycles of biting activity. These, while usually very constant for a given environment, may be entirely different in another. Further, they may show very striking differences at different levels above ground within the same environment. No single explanation fits all the known cases.

(Director, East African Virus Research Institute.)

Cf. A. J. Haddow, 'The mosquitoes of Bwamba County, Uganda. II. Biting activity with special reference to the influence of microclimate', *Bull. Ent. Res.* **36,** 33–73 (1945); 'Studies of the biting-habits of African mosquitoes. An appraisal of methods employed, with special reference to the twenty-four-hour catch', *Bull. Ent. Res.*, **45,** 199–242 (1954); A. J. Haddow & J. D. Gillett, 'Laboratory observations on the oviposition-cycle in the mosquito *Taeniorhynchus* (*Coquillettidia fuscopennatus* Theobald', *Ann. Trop. Med. Parasit.* **52,** 320–5 (1958).

Dr. Janet E. Harker.—*Some endogenous contributions to daily rhythms.*

(Fellow of Girton College, Cambridge.)

Dr. C. S. Pittendrigh.—*A general theory of daily rhythms.*

A coupled oscillator model is developed for the behaviour of the innate circadian ('about a day') rhythms of cells and organisms. Its further utility is noted in explaining recent discoveries in thermo- and photo-periodism.

(Dept. of Biology, Princeton U., U.S.A.)

Dr. M. B. Wilkins.—*Rhythms in plants.*

A survey of the occurrence of persistent rhythms in plants will be followed by a more detailed description of a physiological study of the endogenous rhythm in the rate of carbon dioxide output of excised leaves of *Bryophyllum fedtschenkoi.* A brief comparison will be drawn between plant and animal rhythms.

(Assistant Lecturer, Dept. of Botany, King's College, London.)

Cf. N. G. Ball, I. Dyke & M. B. Wilkins, 'The occurrence of endogenous rhythms in the coleoptiles in various cereal genera', *J. Exp. Bot.* **8,** 24, 339–47 (1957); M. B. Wilkins, 'An endogenous rhythm in the rate of CO_2 output of *Bryophyllum*. I. Some preliminary experiments, *J. Exp. Bot.* **10,** 30 (1959); M. B. Wilkins, 'An endogenous rhythm in the rate of CO_2 output of *Bryophyllum*, II. The effects of light and darkness on the phase and period of the rhythm', *J. Exp. Bot.* (in press).

Dr. C. G. Butler.—*The time sense of the honeybee.*

Worker honeybees possess a sense of time which is of considerable value to them when foraging. This time sense has been investigated by several workers and appears to depend on some internal metabolic rhythm showing a well-marked 24-hour periodicity.

(Head of Bee Research Dept., Rothamsted.)

Cf. *The Honey Bee* (O.U.P.); *The World of the Honey Bee* (Collins, New Naturalists' Series).

Dr. A. J. Marshall.—*Internal rhythm and reproduction in birds.*

The internal rhythm of avian reproduction will be discussed in relation to its possible bearing on equatorial and trans-equatorial migration.

(Reader in Zoology and Comparative Anatomy, St. Bartholomew's Hospital Medical College.)

Cf. B. Lofts & A. J. Marshall, 'The post-nuptial occurrence of progestins in the seminiferous tubules of birds', *J. Endocrin.* **19,** 16–21 (1959); A. J. Marshall, *Bower Birds* (Clarendon Press, Oxford, 1954); 'The breeding cycle of the short-tailed shearwater, *Puffinus tenuirostris* (Temminck), in relation to transequatorial migration and its environment', *Proc. Zool. Soc. Lond.* **127,** 489–510; A. J. Marshall & D. L. Serventy, 'The experimental demonstration of an internal rhythm of reproduction in a transequatorial migrant (the short-tailed shearwater, *Puffinus tenuirostris* (Temminck)', *Nature* (1959, in press); A. J. Marshall & M. C. Williams, 'The pre-nuptial migration of the yellow wagtail (*Motacilla flava*) from latitude 0·04′ N.', *Proc. Zool. Soc. Lond.* **132,** 313–20 (1959).

Dr. J. L. Cloudsley-Thompson.—*The synchronisation of animal clocks.*

In recent years rhythmic activities, like the time-sense of birds and insects, have come to be regarded as manifestations of inherent 'clocks'. Biological 'clocks' present two principal problems of physiology: (*a*) temperature-independence in metabolic systems, and (*b*) the synchronisation of innate with environmental rhythms. These two must be related because, although change in light intensity is the chief factor by which animal 'clocks' are synchronised, temperature fluctuations can also be effective.

(University Lecturer in Zoology, King's College, London.)

New Scientist, **6,** (140), 104–5.

Dr. Mary C. C. Lobban.—*Man and the 24-hour clock.*

In most communities, man's activities are geared to a 24-hour day, and many of his physiological processes show a well-marked 24-hour rhythm. Recent investigations in arctic regions have attempted to evaluate the part played by the activity-pattern and the environment of man in the maintenance of these intrinsic rhythms.

(University Demonstrator, The Physiological Laboratory, Cambridge U.)

Monday, September 7

Deer in Britain. (*See entry under K**.)

Genetics and the origin of species.

Prof. J. Heslop-Harrison.

Since an essential property of coexistent biological species of sexually reproducing organisms is that they do not interbreed freely in nature, the origin of species must necessarily involve the breaking up of formerly continuous breeding groups into separate ones. Isolation and its origins have accordingly become focal points in evolutionary research.

(Professor of Botany, Queen's University, Belfast.)

Dr. R. Riley—*The polyploid species.*

About a third of the species of higher plants are polyploids, with chromosome numbers which are multiples of those of other related species. The origin and subsequent development of polyploids is therefore an important aspect of speciation.

(Cytogeneticist, Plant Breeding Institute, Cambridge.)

Cf. R. Riley & V. Chapman, 'Genetic control of the cytologically diploid behaviour of hexaploid wheat', *Nature*, **182**, 713–15 (1958); R. Riley, V. Chapman & G. Kimber, 'Genetic control of chromosome pairing in intergeneric hybrids with wheat', *Nature*, **183**, 1244–6 (1959).

Dr. C. D. Piggott.—*Geographical and ecological isolation.*

The distribution of species is never absolutely continuous. Small-scale discontinuities arise from the patchiness of suitable habitats; large-scale discontinuities have arisen from historical changes in climate, soil and vegetation. Discontinuities have allowed evolutionary divergence and the development of geographical and ecological races. The importance of this type of isolation is made clear by the consequences of its removal by man's modification of vegetation.

(Lecturer, Botany Dept., Sheffield U.)

Dr. J. M. Thoday.—*Divergence without isolation.*

Populations of outbreeding species comprise a great diversity of genetically different individuals that interbreed. This diversity may be very relevant to the capacity of components of the population for evolutionary divergence if the population is split into more or less separate populations. Experimental evidence indicates that heterogeneity of habitat must be considered as a potential force tending to make populations polymorphic for differently adapted forms. Divergence without isolation is a possibility and might add to the efficacy of subsequently imposed isolating factors.

(Head of Dept. of Genetics, Sheffield U.)

Dr. P. Sheppard.—*Adaptation and co-adaptation.*

A change in the environment can cause a change in the direction and intensity of natural selection and therefore an alteration in the genetic make-up of the individuals in a population. The local adjustment of populations to their habitat is illustrated by a study of the mimetic butterfly *Papilio dardanus.*

(Senior Lecturer in Genetics, Liverpool U.)

Dr. A. J. Bateman.—*Mating preferences within species.*

An account of the various ways in which sexual isolation can operate within a species; in animals by making preferences; in plants by preferences exhibited by pollinating insects. In such species there will be a centrifugal force tending to speciation.

(Principal Research Asst., N.H.S.)

Cf. 'Intrasexual selection in Drosophila', *Heredity*, **2**, 349 (1948); 'Analysis of data on sexual isolation', *Evolution*, **3**, 174 (1949); 'The taxonomii discrimination of bees', *Heredity*, **5**, 271 (1951).

Prof. K. Mather, C.B.E., F.R.S.—'*Conclusions*'.
(Professor of Genetics, Birmingham U.)

Zoological films (*in Section D's room*):

(*a*) *First few hours:* the first moments of life of a number of species.
(*b*) *Table manners:* a survey of animal feeding habits.
(*c*) *So much like us:* an analysis of chimpanzee intelligence.

These films have been made at the London Zoo by the Granada/Zoo Film Unit.

Tuesday, September 8

The Yorkshire flora and fauna and its conservation. (*Joint session with Section K (Botany)*):

(*For references see entry under Section K*)

Prof. E. A. Spaul.—*Introduction.*
(Professor of Zoology, Leeds U.)

Dr. E. A. G. Duffey.—*The scientific management of Nature Reserves.*

The conservation of plant and animal associations on national Nature Reserves can only be successful if it is based on study of the factors which have influenced the development of these communities and of the special requirements of species of particular interest. Examples to illustrate this will be given.

(Regional Officer, The Nature Conservancy, East Anglia.)

Mr. P. F. Holmes.—*Nature conservation at a Yorkshire Field Centre.*

Malham Tarn is National Trust property, leased to the Field Studies Council, which uses it as a Field Centre and treats the area as a Nature Reserve. The effects of public access and of having large numbers of students will be discussed, together with the possibilities of teaching conservation ideas at Field Centres.

(Warden of Malham Tarn Field Centre.)

Mr. C. J. Smith.—*The work of the Yorkshire Naturalists' Trust.*

County Naturalists' Trusts have an important role in nature conservation. An account will be given of the work of the Yorkshire Naturalists' Trust with special reference to Askham Bog Nature Reserve, and the scope for future activities in Yorkshire will be discussed.

(Senior Science Master, Bootham School, York.)

Dr. W. A. Sledge.—*Botanical aspects of conservation in Yorkshire.*

A survey of the botanical importance of existing nature reserves in Yorkshire and of unconserved areas which merit consideration on grounds of special botanical interest.

(Senior Lecturer, Botany Dept., Leeds U.)

General discussion, with concluding remarks by Mr. E. M. Nicholson, C.B.

(Director-General, The Nature Conservancy.)

The evolution of host-parasite relationships:

General report to appear in *Nature*.

Prof. J. G. Baer.—*An ecological survey of host-parasite relationships.*

By approaching the problem in certain groups of ecto- and endoparasites from an ecological angle, an attempt is made to find out the respective roles of genetical and ecological factors and their influences on the evolution of the host-parasite relationships.

(Director of the Zoological Institute and Professor of Zoology and Comparative Anatomy, University of Neuchâtel.)

Prof. W. E. Kershaw.—*The evolution of human filariae.*

The filarial parasites of man are in different stages of evolution. Some are restricted to man, some parasitise man and animals and others are separating into human and animal strains.

(Professor of Parasitology and Entomology, Liverpool School of Tropical Medicine.)

Dr. C. A. Wright.—*The relationships between trematodes and molluscs.*

Little attention has been given to the problem of speciation in the digenetic trematodes. It is suggested that the phase of the life-cycle in which the molluscan host is concerned is of importance in this respect, and a description is given of one possible mechanism which may be involved.

(British Museum (Natural History).)

Dr. Theresa Clay.—*The evolution of host-parasite relationships in the Mallophaga of birds.*

Some aspects of the biology and distribution of the Mallophaga or featherlice, a group of insects parasitic on birds, and some deductions about their evolution. The relationships and distributions of the Mallophaga as an aid to the classification of birds.

(Dept. of Entomology, British Museum (Natural History).)

Cf. *First symposium on host specificity among parasites of Vertebrates*, 120–54 (Institut de Zoologie, Université de Neuchâtel, 1957).

Wednesday, September 9

Dr. S. Smith.—*The origin of 'The Origin'.*

An examination of the Darwin papers at Cambridge and of Charles' annotations in his books at Down House permits the reconstruction of the outline programme of his reading in the decisive period of 1837 to 1842, during which his ideas concerning the transmutation of species were being developed. The conclusions support Darwin rather than his commentators.

(Lecturer in Zoology, Cambridge U.)

Dr. C. B. Goodhart.—*Human hair and blushing.*

Human hair is well developed, but patchy in its distribution. Comparison with other mammals suggests that these patches are not mere vestiges of a continuous furry coat, but originally had various specific functions. There are indications also that skin-flushing may have had some functional significance in man.

(Assistant Curator of Invertebrates, University Museum of Zoology, Cambridge.)

SECTION E
GEOGRAPHY

Thursday, September 3

Dr. H. C. K. Henderson.—*Changes in the industrial geography of the West Riding*, 1921–51.

The distribution discussed at the York Meeting, 1932, will be compared with that based on the 1951 Census.

(Reader in Geography, Birkbeck College, London U.)

Mr. D. I. Scargill.—*The West Yorkshire conurbation in* 1851 *and* 1951: *a comparison.*

Owing to its topographical character and economic history textile West Yorkshire of 1851 displayed characteristics now called 'conurban'. The conurbation of 1951 is said to be the least obvious of the Registrar-General's six major conurbations. This paper will indicate the influence of its 1851 nature on modern West Yorkshire.

(Research graduate, Oxford U.)

Mr. J. A. Patmore.—*Harrogate: the development of an inland resort.*

The function of Harrogate as a spa and inland resort is examined in relation to its development in the nineteenth and twentieth centuries. Particular reference is made to the changing origins and nature of its visitors.

(Lecturer in Geography, Liverpool U.)

Mr. R. O. Smith.—*York and its geographical setting.*

An assessment of the changing influence of site and situation on the growth of York and the development of its functions, with special reference to significant phases in the history of the city.

(Senior Lecturer in Geography, St. John's College, York.)

Friday, September 4

PRESIDENTIAL ADDRESS by Prof. K. C. Edwards on *Trends in urban expansion.*

(Professor of Geography, Nottingham U.)

Mr. A. G. Powell.—*The expansion of London.*

A review of development in the Greater London Region since the Barlow Report with special reference to trends since 1952. A re-definition of the Region, and conclusions on the effectiveness of the planning of Greater London and the practicability of controlling the growth of metropolitan conurbations.

(Senior Research Officer, Ministry of Housing and Local Government.)

Coastal erosion and coast protection. (*Joint session with Section K (Botany)*):

To appear in *Nature.*

Prof. J. A. Steers.—*Introduction.*
(President, St. Catharine's College, and Professor of Geography, Cambridge U.)

Dr. M. C. Pearson.—*The biology of the Sea Buckthorn* (Hippophaë rhamnoides *L.*)

The past and present distribution of the plants. An account of the environment in which the plant grows, with particular reference to the substrate in which the plant is rooted. The floristics and structure of the community in which the plant occurs. Problems concerning the reproduction of the plant. Germination experiments.

(Lecturer, Nottingham U.)

Mr. R. K. Gresswell.—*Coast erosion and coast protection in Lancashire.*

Almost the entire coast of Lancashire is in boulder clay, sand, or other unconsolidated deposits and its continued existence is only possible because of the small waves on the enclosed Irish Sea. Both erosion and accretion occur juxtaposed and much control has been engineered in certain areas.

(Special Lecturer in Geography, Liverpool U.)

Mr. C. Kidson.—*The uses and limitations of vegetation in shore stabilisation.*

On a relatively short stretch of our coasts vegetation can be used as the sole defence against erosion. On a much longer stretch vegetation can be used in support of protective structures. Examples of the use of different types of vegetation and the stabilisation of differing shores (mud, sand, shingle) are given.

(Head of Coastal Physiographical Research Unit, Nature Conservancy.)

Mr. G. Cole.—*The use of certain plants as stabilisers of marine sediments.*

A review of the experience of some sea defence engineers and others in the use of various grasses and other plants to stabilise wind-borne sand and water-borne silt, and of some possible future developments.

Monday, September 7

Microseisms and storms (*See entry under Section A (Physics).*)

Land use surveys of the world:

Prof. L. Dudley Stamp, C.B.E.—*The work of the World Land Use Survey.*
(Director of Land Utilisation Survey of Great Britain; Emeritus Professor of Social Geography, London U.)

Mr. C. Board.—*Land use in an African borderland.*

The aims of the survey; the difficulties of land use classification. An analysis and explanation of the land use pattern in three contrasting land use regions.

(Tutor in Geography, U.C., Swansea.)

Mr. M. Brunt.—*The Gambia land use and vegetation survey.*

This paper describes the land use survey of the Gambia, the method and techniques employed, and considers the results of the survey and their practical applications.

(Land Use Officer, Directorate of Overseas Surveys, Colonial Office.)

Soils, III, No. 28 (1959).

Mr. W. D. Clayton.—*Vegetation survey in Nigeria.*

An account of the conduct of vegetation surveys in a tropical country, and an interpretation in terms of soil and land use.

(S.S.O., The Herbarium, Kew.)

Cf. 'The swamps and dunes of Hadejia', *Nig. Geogr. J.* **1**, 31 (1957); 'Report on the vegetation of Map Sheet 181', Min. of Agric. N. Nigeria, Soil Survey Section: *Bull. No. 4*; 'Secondary vegetation and the transition to rovanna near Ibadan, Nigeria', *J. Ecol.* **46**, 217 (1958).

Mr. V. C. Robertson.—*A development study in Western Sudan.*

A preliminary study of 12,000 square miles of country in the western part of Darfur Province, Sudan, was commissioned by the Sudan Government to explore the possibilities for water conservation and irrigation development. The study used aerial photographs and a mixed team of specialists in the field using ground transport and a helicopter.

(Technical Director, Hunting Technical Services Ltd.)

Cf. 'Aerial photography and proper land utilisation', *Photogrammetric Record*, **1**, No. 6, 512 (Oct. 1955); 'The modern approach to land development', *F.B.I. Rev.* (Jan. 1957); 'Western Darfur and the Jebel Marra', *Sudan Silva No. 8*, **1**, (Nov. 1958).

Mr. R. G. Miller.—*Surveys of forest resources.*

The use of aerial photographs and statistical sampling methods have greatly improved the techniques for undertaking extensive forest surveys. Some results of these and other developments will be described in relation to both local and general surveys of forest resources.

(Assistant Director, Forestry & Land Use Section, Directorate of Overseas Surveys, Colonial Office.)

Discussion. Speakers include Prof. S. van Valkenburg, Clark University, U.S.A., and Prof. J. Macdonald Holmes, Sydney, Australia.

Tuesday, September 8

Prof. Dr. C. Troll.—*The work of Alexander von Humboldt and Carl Ritter.*

A centenary address.

(Director, Institute of Geography, Bonn University, Germany.)

Prof. W. B. Fisher.—*Twenty-five years of T.V.A.*

T.V.A. was started primarily as a public works project to provide employment during a time of economic depression. Since 1933 its scope of operations has extended in ways not originally envisaged, involving problems of general development both regionally and for the U.S.A. as a whole.

(Professor of Geography, Durham Colleges, Durham U.)

Prof. B. J. L. Berry.—*Highway development and geographical change in the U.S.A.*

A description of the land use, business and travel adjustments of a specialised economy, and changes in the availability and efficiency of transport facilities.

(Assistant Professor in Geography, University of Chicago, U.S.A.)

Wednesday, September 9

Dr. G. T. Warwick, M.B.E.—*The limestone regions of Britain and their morphological development.*

This communication concerns the chief karstic phenomena to be found in British limestone regions, and assessment of their relative importance, and two models for the development of limestone scenery on Palaeozoic and Mesozoic limestones. A brief comparison between some British limestone areas and these models is also made.

(Lecturer in Geography, Birmingham U.)

Cf. 'The characteristics and development of limestone regions in the British Isles with special reference to England and Wales', to appear in *Proc. 2nd International Speleological Congress, Bari, 1958.*

Miss M. Bower.—*Peat erosion in the Pennines.*

The distribution of active peat erosion has been mapped in the Pennines from aerial photographs and its extent will be outlined and interpreted. The nature and methods of erosion will be examined and related to the relevant factors.

(Tutor in Geography, Liverpool U.)

Mr. E. Derbyshire.—*The significance of Knob lake, central Quebec-Labrador, as a field research centre.*

An outline of the field research achieved to date by McGill Subarctic Research Laboratory since its establishment in 1954, together with a discussion of

future plans for dealing with the more outstanding problems posed by this region of subarctic Canada.

(Demonstrator in Geography, University College of North Staffordshire.)

Mr. B. E. Coates.—*The distribution of landscape parks of the West and East Ridings of Yorkshire.*

The present-day distribution and extent of parkland is outlined in terms of geological, pedological and agricultural regions. In the light of the requirements of the park-builders, with regard to site and situation for particular landscape styles and estates, some explanations of both general and local significance are suggested.

(Junior Research Fellow, Sheffield U.)

SECTION F
ECONOMICS

Thursday, September 3

Restrictive Trade Practices Act:

To appear in *Yorkshire Bulletin of Economic and Social Research* (early 1960)

Prof. Arthur Beacham.

(Professor of Economics and Political Economy, University College of Wales, Aberystwyth.)

Prof. S. R. Dennison.

Critiques of certain aspects of the working of the latest British experiment in monopoly control as embodied in the Restrictive Trade Practices Act, 1956.

(Professor of Economics, The Queen's University, Belfast.)

Mr. R. L. Sich, C.B.—*The Restrictive Trade Practices Act, 1956, in operation.*

(Registrar of Restrictive Trading Agreements.)

Board of Trade Journal (Sept. 25, 1959); expected to appear in *Yorkshire Bulletin of Economic and Social Research.*

Prof. B. R. Williams.—*Conditions of effective competition.*

Competition affects both the relation between prices and costs and the level of costs. Economists have given insufficient attention to the second relation. The effectiveness of competition in stimulating innovation varies with the available supply of scientists and technologists, background scientific knowledge of processes, growth rates, etc. Competition (and restrictions on it) to be considered in relation to varying opportunities to innovate.

(Professor of Economics, University College of North Staffordshire.)

Mr. A. A. Shenfield.—*The theory of social balance.*

An examination of views set out in *The Affluent Society* by J. K. Galbraith on the relation between public and private provision of consumers' goods and services.

(Economic Director, F.B.I.)

Friday, September 4

PRESIDENTIAL ADDRESS by Prof. John Jewkes, C.B.E., on *How much science?*

(Professor of Economic Organisation, Oxford U.)

Mr. J. Black.—*The cost of national superannuation.*

An analysis of the relation of the probable total cost of a national superannuation scheme to the national income; with a discussion of the effects of alternative assumptions about the method of financing, the rate of earnings on any accumulated funds, and the age of retirement under such a scheme.

(Fellow and Tutor in Economics, Merton College, Oxford.)

Cf. 'A note on the economics of national superannuation', *Economic J.* (June 1958).

Mr. Gordon Mills.—*Public patronage and the arts.*

A national income accounting analysis of the total expenditure on the arts in Great Britain since 1920. The extent to which there should be public patronage of the arts in a welfare state will be discussed.

(Asst. Lecturer in Economic Statistics, Sheffield U.)

Monday, September 7

Seebohm Rowntree:

Mr. R. W. Drinkwater.—*Seebohm Rowntree's contribution to the study of poverty.*

The purpose of the paper is to review the concepts, techniques and standards employed by Rowntree in his studies of poverty in York, to assess briefly their influence on other workers in this field, and to examine them in the light of some current ideas on subsistence measurement.

(Head of Dept. of Social Studies, Hull U.)

Mr. W. Wallace, C.B.E.—*A tribute to the life and work of Seebohm Rowntree.*

(Formerly Chairman of Rowntree & Co. Ltd.)

Prof. T. Wilson, O.B.E.—*The affluent society: another view.*

(Professor of Political Economy, Glasgow U.)

The Welfare State:

Mr. A. Gabor.—*The economics of the Welfare State in Britain.*

In popular thought only those activities are identified with welfare which aim to help the underprivileged and permanently or temporarily handicapped members of the community. It will be argued that the true scope of the Welfare State is much wider and embraces many seemingly distant fields.

(Senior Lecturer in Economics, Nottingham U.)

Mr. G. A. Petch.—*The Welfare State and modern West Africa.*

Welfare aspects of the 'original' economies and the changes which have taken place in the twentieth century. The methods of achieving economic security and welfare which have developed and the matters involved in attempting to produce the complete Welfare State in modern West Africa.

(Senior Lecturer in Economics, King's College, Durham U.)

Tuesday, September 8

Aspects of transport economics. (*Joint session with Section G (Engineering)*): (*For references see under Section G*)

Dr. G. Charlesworth, Mr. D. J. Reynolds, Mr. J. G. Wardrop.—*Road traffic and economics.*

Importance of road transport in the economy; conditions on the roads at present; costs of road transport; ways of increasing the economic efficiency of road transport; economic traffic capacity of roads; economic assessment of priorities for road works.

(Road Research Laboratory, D.S.I.R.)

Sir Reginald Wilson.—*The economics of transport.*

Chaos and waste could occur on a grand scale unless engineers and economists combine to reconsider their formulae. How can we assess the comparative costs of road and rail? And the social benefits? Final policy remains an art, and no simple 'solution' exists, but important aspects of the 'problem' can and should be kept under scientific review.

(Member of British Transport Commission.)

Discussion to be opened by Mr. G. J. Ponsonby, Sir Ernest Cassell Reader in Commerce, with special reference to transport, at the London School of Economics.

SECTION G

ENGINEERING

Thursday, September 3

Session A

Mr. G. F. Fiennes.—*The future of inland freight transport.*

The national demand; present and future; the choice of transport; present advantages and disadvantages of each form and technical advances in prospect. Prospect of too much freight transport; effect of surplus on national well-being; competition; regulation; integration. Each to its proper task.

(Line Traffic Manager, Great Northern, British Railways.)

To appear in *Engineering* and (shortened version) in *Research.*

Session B

Dr. E. M. Patterson.—*High-speed photographic analysis of blasting in coal-bearing strata.*

In multi-shot rock blasting by high explosives several practical advantages accrue from firing the shots in a controlled sequence with short time intervals or 'delays' between them. A fuller understanding of the mechanism of a particular type of blast and choice of the best delay interval, can be obtained by high-speed photography.

(Technical Officer, Nobel Division, I.C.I. Ltd.)

To appear in *Engineering.*

Cf. 'Photography applied to the study of rock blasting', *J. Phot. Sci.* **5**, 137–43 (1957).

Sessions A and B

Hon. Lionel Chevrier, P.C. (Canada), Q.C.—*The St. Lawrence Seaway.*
(President of the St. Lawrence Seaway Authority 1954–57).

Cf. Lionel Chevrier, *The St. Lawrence Seaway*; 'Fall ocean rate war looms', *Montreal Gazette* (Montreal, Canada, Aug. 7, 1959); *The St. Lawrence Seaway Authority* (Ottawa, Canada); *St. Lawrence Seaway Development Corporation* (Massena, New York); *Department of Transport* (Ottawa, Canada); *Department of Trade and Commerce* (Ottawa, Canada); *Financial Post* (Toronto, Canada, Mar. 21, 1959); *Winnipeg Free Press* (Winnipeg, Canada, July 4, 1959); *Montreal Gazette*, (Montreal, Canada, July 10, 1959); *Wall Street Journal* (N. Y., July 16, 1959); *New York Times* (N. Y., July 25, 1959).

Friday, September 4

Sessions A and B

PRESIDENTIAL ADDRESS by Sir Ewart Smith, F.R.S., on *The critical importance of communication and transport.*
(Until March, 1959, Deputy Chairman of Imperial Chemical Industries Limited.)

Session A

Mr. S. B. Warder.—*Railway electrification in Britain.*

The factors governing the rate of extension and the technical means employed in railway electrification in different countries are discussed together with the origins of the 50-cycle single-phase system and the reasons for its adoption by the British Transport Commission. The electrical equipment of the rolling stock under construction for British Railways is described together with the means of overcoming difficulties in installing overhead contact wire within the limited clearances available on British Railways.

(Chief Electrical Engineer, British Railways Division, British Transport Commission.)

Session B

Mr. O. A. Kerensky.—*Bridges.*

Major steps in the development of the art of bridge construction. Types of bridges, methods of erection, materials. Modern trends in design, fabrication and erection. Some notable bridges. Bridge problems in Britain today.

(Partner of Freeman, Fox & Partners, Consulting Engineers.)

Engineering (Sept. 11, 1959).
Cf. *Structural Engineer* (Oct. 1958, July 1959).

Monday, September 7

Session A

Mr. W. K. Laing.—*Construction of London to Birmingham Motorway.*

The paper deals with the relation of the motor-way programme to the existing road system. It considers the planning and organisational problems involved together with the actual construction of a project valued at sixteen million pounds spread over a distance of 55 miles within a contract period of 19 months.

(Chairman, John Laing & Son (Holdings) Ltd.)

To appear in *Engineering*.

Brigadier G. H. Hinds.—*Computers in transport.*

An account of the use of computers and of computer techniques by the British Transport Commission, and of investigations into possible future applications. Emphasis is given to requirements for specialised equipment, and to cases where computers have been or may be used for scientific or engineering purposes.

(Electronics Advisory Officer, British Transport Commission.)

To appear in *Engineering*.
Cf. 'Electronics on railways', *Manchester Guardian* (Sept. 27, 1957); 'Computers in transport', *British Transport Rev.* (Apr. 1958); 'Electronic aids to transport', *Financial Times* (Aug. 18, 1958); 'E.D.P.—the short cut to factory efficiency', *Times Rev. of Industry* (Nov. 1958).

Session B

Papers by young engineers:

Dr. B. Wilson.—*Xenon poisoning studies in a nuclear reactor using a simple analogue computer.*

Xenon-135, found during the operation of a nuclear reactor, is a poison which tends to reduce the effectiveness of the control mechanism. A simple analogue computer is developed to investigate the change in concentration of this poison over specific periods of a reactor programme.

(Senior Research Engineer, Reactor Control Department, Ericsson Telephones Limited.)

To appear in *Engineering*.

Mr. L. Bernstein.—*Some factors affecting the performance and design of a hypersonic shock-tube wind-tunnel.*

The hypersonic shock-tube wind-funnel as a facility for simulating high speed flight is described. Real gas effects are discussed particularly as they affect tunnel testing-time. Current measuring techniques are described and the work in progress at Queen Mary College is outlined.

(Aeronautical Engineering Dept., Queen Mary College, London.)

Dr. A. G. Raper.—*Mass transfer experiments with finned heat exchanger tubes.*

A method is described by which the local heat transfer coefficients for finned heat exchanger tubes can be determined by measuring the mass transfer from model

(Research and Development Dept., Head, Wrightson & Co. Ltd.)

Mr. J. V. Parry and Mr. M. T. G. Hughes—*Application of the phase-plane method to the study and transient optimisation of a relay servomechanism.*

The paper describes, using phase-plane diagrams, the operation of relay servomechanisms with different forms of damping. Particular reference is made

to a system employing nonlinear damping to optimise the transient response. Experimental results are given for an 'optimised' relay-operated instrument servomechanism, and these are compared with results obtained for other forms of damping.

(Department of Electrical Engineering, University of Nottingham.)

Tuesday, September 8

Session A

Radiation damage (*see entry under Section A*)

Aspects of transport economics. (*Joint session with Section F (Economics)*

Dr. G. Charlesworth, Mr. J. G. Wardrop and Mr. D. J. Reynolds.—*Road traffic and economics.*

Importance of road transport in the economy; conditions on the roads at present; costs of road transport; ways of increasing the economic efficiency of road transport; economic traffic capacity of roads; economic assessment of priorities for road works.

(Traffic and Safety Division D.S.I.R. Road Research Laboratory, Langley)

Engineering, **188**, No. 4873, 185–8 (1959).

Sir Reginald Wilson.—*The economics of transport (with special reference to road/rail questions in the United Kingdom).*

Chaos and waste could occur on a grand scale unless engineers and economists combine to reconsider their formulae. How can we assess the comparative costs of road and rail? And the social benefits? Final policy remains an art, and no simple 'solution' exists, but important aspects of the 'problem' can and should be kept under scientific review.

(Member of British Transport Commission.)

Summary in *The Engineer*.

Discussion opened by Mr. G. J. Ponsonby, Sir Ernest Cassel Reader in Commerce, with special reference to Transport, at the London School of Economics.

Session B

Mr. E. S. Cox.—*Application of diesel engines and gas turbines to rail transport.*

The background and problems of diesel traction development are described. Some technical results are quoted and the lessons learned from current experience are referred to. The effects of these on possible future diesel development are discussed, and reference is made to the role of the gas turbine for traction purposes.

(Assistant Chief Mechanical Engineer, British Railways Division, British Transport Commission.)

Mr. H. G. Conway.—*VTOL: An aeronautical challenge.*

The paper deals with modern development of vertical take-off aircraft, with particular reference to the Rolls-Royce jet lift power plants and the Short S.C.I. aircraft. Future prospects for civil and military aircraft are considered.

(Director and Chief Engineer, Short Brothers & Harland Limited.)

SECTION H

ANTHROPOLOGY

Thursday, September 3

Hunting and trapping:

Prof. J. G. D. Clark, F.B.A.—*Chairman's introduction.*

(Disney Professor of Archaeology, Cambridge U.)

Dr. J. Waechter.—*Palaeolithic and Eskimo: a study in economy and environment.*

The economic approach to Palaeolithic studies is becoming increasingly important and a great deal more information has become available in the last few years. These studies cannot be divorced from the environmental conditions under which palaeolithic man lived. The purpose of this communication is to compare the environmental and economic conditions of the last phase of the last glaciation with that of the Caribou Eskimo whose environmental conditions are very similar and whose economy is comparatively well known.

(Lecturer in Palaeolithic Archaeology, Inst. of Archaeology, London U.)

Dr. H. Rasmussen.—*Prehistoric and recent basket traps for fishing in Denmark.*

Basket traps are known in quite a considerable number from the Danish Mesolithic period and they do not differ much from the recent ones which are still used in old-fashioned coastal fisheries, especially for eels. The technique of making and using basket traps is explained by means of recent material.

(Curator, Odense Bys Museum, Denmark.)

Mr. D. M. Boston.—*The bushmen of southern Africa.*

A description of the methods and equipment used by the bushmen in hunting and trapping based on contemporary, historical and archaeological evidence.

(Special Officer in Archaeology and Ethnology, City of Liverpool Museums from 1956.)

Cine-film.—*Bushmen of the Central Kalahari.*

Friday, September, 4

Linguistic surveys in Britain:

Dr. Iorwerth C. Peate.—*Chairman's introduction.*

(Curator, Welsh Folk Museum, St. Fagan's, Cardiff.)

Prof. H. Orton.—*The survey of English dialects.*

The paper will report on the work already done towards the compilation of the proposed Linguistic Atlas of England. Fieldwork at 279 of the network of 300 localities in rural England is complete, and the first of four massive volumes of basic material is in active preparation.

(Professor of English Language and Mediaeval English Literature, Leeds U.)

To appear in *Orbis* (Bulletin International de Documentation linguistique, Louvain).

Cf. *English studies today, papers read at the International Conference of University Professors of English* (O.U.P., 1959).

Mr. T. Hill.—*Dialect research in Scotland.*

The situation of the dialects of Scotland (i.e. dialects of Scots and Gaelic), their sociological position vis-a-vis English and the methods used in studying them, especially certain techniques which are new or controversial, and have relevance for the general theory of scientific method.

(Lecturer, Linguistic Survey for Scotland, Edinburgh U.)

Mr. V. H. Phillips.—*Dialect research in Wales.*

A review of present-day research into dialect and related material in Wales.

(Asst. Curator of the Welsh Folk Museum, St. Fagan's, Cardiff.)

Discussion to be opened by Mr. S. F. Sanderson.

Radiocarbon dating. (*See entry under Section A.*)

Monday, September 7

PRESIDENTIAL ADDRESS by Prof. Ian A. Richmond, C.B.E., F.B.A. on *The nature and scope of archaeology.*

(Professor of Archaeology of the Roman Empire in the University of Oxford.)

Local archaeology:

Mr. E. T. Cowling.—*West Yorkshire cup and ring markings.*

What they are—where they are—first examples and following sequence. Other groups—dates—meanings—show local settlement—persistence of Neolithic beliefs into Beaker times and onwards.

(Author.)

Dr. D. Brothwell.—*The Bronze Age population of Yorkshire.*

A general review of the Bronze Age skeletal material from Yorkshire. A consideration of their morphological affinities with other groups, and their health.

(Demonstrator in Physical Anthropology, Cambridge U.)

Mr. T. C. M. Brewster.—*The excavation of Staple Howe, Knapton, East Yorkshire.*

A brief account of the excavation of the Staple Howe Iron Age 'A' settlement, its structure, pottery and small finds and their evaluation.

(Schoolmaster.)

Prof. R. Warwick.—*The people of the Trentholme Drive cemetery at York.*

An analysis of the skeletal material from this Roman cemetery.

(Prof. of Anatomy in the University of London at Guy's Hospital Medical School.)

Dr. M. L. Ryder.—*The animal remains from four mediaeval sites in Yorkshire.*

The skeletal remains of domestic and other animals, including birds and fish, from Kirkstall Abbey; St. John's Priory, Pontefract; a site in Petergate, York, and the deserted village of Wharram Percy: the species, the relative numbers, age when killed, size and breed type of the animals and signs of disease in the bones.

(S.S.O., Biology Dept., Wool Industries Research Association, Leeds.)

Dr. G. I. Boyd.—*The Scarborough collection and its sexing: a critical survey.*

A re-examination of the Scarborough collection of mediaeval skeletons made from 1953 onwards, on its return to London after war-time removal; an assessment of the damage and a re-sexing of the adult skeletons with post-cranial bones. Published work on this collection is reviewed.

(Senior Lecturer in Anatomy, Leeds U.)

Discussion opened by Mrs. M. Smith.

Tuesday, September 8

Saxon and Viking York:

Dr. Rosemary Cramp.—*Alcuin and the York tradition of literature and learning.*

A consideration of what Alcuin and other writers, mainly of the pre-ninth century, can show us of the traditions of learning of the school at York, its teaching and influence abroad, its literary and artistic interests.

(Lecturer in Anglo-Saxon antiquities and archaeology in the Durham Colleges, Durham U.)

Mr. I. Stead.—*Dark Age and Anglo-Danish York: the archaeological evidence.*

Mr. K. Harrison.—*The Saxon churches of York.*

An account of buildings known to exist between A.D. 627 and the Conquest; continuity of the See throughout the Danish invasions; remarks on the cathedral library; recent views on York as a source of chronicles and annals.

(Fellow of King's College, Cambridge.)

Mr. T. French.—*York domestic architecture*

(Senior Investigator, Royal Commission on Historical Monuments.)

Wednesday, September 9

Chemistry in the preservation of antiquities. (*See entry under Section B.*)

SECTION I

PHYSIOLOGY AND BIOCHEMISTRY

Thursday, September 3

Dental health:

Lady Mellanby.—*Chairman's introduction: the structure of dental tissues in relation to disease.*

The ultra-microscopical structure of a tooth, especially of the enamel will be discussed during the course of the Symposium. It is very complicated and has until recently been little understood. I shall use the term in a relatively gross sense referring mainly to the surface texture, the amount of tissue in relation to the normal for a given type and its histological build.

(Dental Research Worker, M.R.C.)

Dr. J. L. Hardwick.—*The structure of the teeth in relation to dental decay.*

Including a survey of our knowledge of the effects of nutrition and of the war-time diet on the subsequent susceptibility of teeth to decay.

(Reader in Dental Surgery, Birmingham U.)

Dr. R. L. Hartles.—*The environment of the teeth in relation to dental decay.*

A major factor in the decay of a tooth is the condition of its local environment. The individual can do much to help in preventing the onset of decay. Tooth decay can never be cured but good oral hygiene and sound dietary habits can help in its prevention.

(Senior Lecturer in Dental Biochemistry, School of Dental Surgery, Liverpool U.)

Dr. G. N. Jenkins.—*The prevention of dental decay by fluoride.*

The evidence showing that fluoride-containing water supplies are associated with a low incidence of dental decay and the results of artificial fluoridation will be reviewed. The mode of action of fluoride will be discussed.

(Reader in Oral Physiology, King's College Medical School, Durham U.)

Cf. 'The pros and cons of fluoridation", *Brit. Dent. J.*, **99**, 249.

Prof. E. W. Bradford.—*The supporting structures of the teeth and periodontal disease.*

Periodontal disease or pyorrhoea is looked upon by the public as a disease which is incurable and so necessitates the extraction of all the teeth. It is hoped to explain that in a large number of cases this is far from true.

(Professor of Dental Surgery, Bristol U.)

Friday, September 4

The culture of tissues and organs outside the body:

Dr. J. Paul.—*Recent technical advances in cell culture.*

Within the past ten years, methods have been developed which permit accurate quantitative manipulation of animal cells. These depend mainly on the production of suspensions, in which the cells can be counted. They can be grown in suspension or in monolayers on glass and colonies can be grown from single cells.

(Director, H.E.R.T. Tissue Culture Laboratory, Glasgow U.)

Cf. *Cell and Tissue Culture* (E. & S. Livingstone, 1959); 'Modern methods of cell and tissue culture', *Clinical Practice* (to appear shortly).

Dr. O. A. Trowell.—*The culture of mature organs* in vitro.

Organs removed from rats and mice can be kept alive under artificial conditions in the laboratory for a week or more. The technical problems involved

and methods used will be discussed. Some of the biological problems which have been solved by this means will be described.

(Senior Scientist, M.R.C. Radiobiological Unit, Harwell.)

Cf. 'The culture of mature organs in a synthetic medium', *Exp. Cell Res.* **16**, 118 (1959).

Dr. Ilse Lasnitzki.—*Cancer development in organ cultures.*

Carcinogens added to the medium of organ cultures of human lung and mouse prostate gland induce overgrowth of their epithelial structures combined with cytological abnormalities. Sex hormones and excess vitamin A influence the extent and type of the overgrowth. DNA synthesis and amino acid utilisation were measured in control and treated cultures.

(Sir Halley Stewart Fellow, Strangeways Research Laboratory, Cambridge.)

Dr. I. Leslie.—*Differences between normal and cancer cells.*

The aim of much cancer research is to find vital differences between normal and malignant cells, which may lead to improved forms of treatment. Progress in this direction is being made by the increasing use of new biochemical and tissue culture techniques.

(Lecturer in Biochemistry Dept., Queen's University, Belfast.)

Cf. I. Leslie, W. C. Fulton & R. Sinclair, 'Biochemical tests for malignancy applied to a new strain of human cells', *Nature*, **178**, 1179–80 (1956); I. Leslie, W. C. Fulton & R. Sinclair, 'The metabolism of human embryonic and malignant cells and their response to insulin', *Biochim. Biophys. Acta*, **24**, 365–80 (1957).

Monday, September 7

Artificial organs:

PRESIDENTIAL ADDRESS by Prof. A. Hemingway on *Artificial organs: biological applications.*

A survey of the physiological principles involved in the design and the use of artificial systems in biological research and their application to medical practice including the development of the 'artificial kidney' and the heart-lung machine.

(Professor of Physiology, School of Medicine, Leeds U.)

Dr. D. G. Melrose.—*Elective arrest of the heart-beat.*

The technical problems involved in open operation within the heart are discussed briefly and are followed by a short review of the methods at present available to overcome them. An account is given of experimental work leading up to the development of a method of elective cardiac arrest. The place of such a method in intracardiac surgery in man is discussed.

(Lecturer in Surgical Physiology, Post Graduate Medical School, W.12.)

Dr. J. L. Linzell.—*The use of the perfused mammary gland in the study of milk secretion.*

Mammary glands can be kept alive off the body for some hours by perfusing them with blood or a simpler artificial perfusate and the chemicals and hormones that must be added for milk to be formed are being studied. Comparisons with normal glands and conditions necessary for optimum activity will be discussed.

(P.S.O., A.R.C. Institute of Animal Physiology, Babraham, Cambridge.)

Cf. H. E. C. Cargill-Thompson, A. N. Drury, D. C. Hardwick, J. L. Linzell & E. M. Tucker, *J. of Physiol.* **143**, 74 (1958).

Tuesday, September 8

Radiation damage. (*See entry under Section A* (*Mathematics and Physics*).

Kidneys.—natural and artificial:

Prof. D. A. K. Black.—*Body-fluid and the kidney.*

Body-fluid accounts for more than half the body-weight. Its amount and composition are regulated mainly by the kidneys, which can compensate for

wide variation in intake and in non-renal losses. This communication outlines the distribution, composition and regulation of body-fluid.

(Professor of Medicine, Manchester U.)

Cf. *Essentials of Fluid Balance* (2nd ed., Blackwells, Oxford, 1959).

Dr. F. M. Parsons.—*Use of the artificial kidney.*

1. Biochemical abnormalities encountered in renal failure.
2. Description of the artificial kidney.
3. Function of the artificial kidney (with reference to the communications of Prof. Black and Dr. O'Connor).
4. Clinical indications for using the artificial kidney.
5. Results.

(Assistant Director, Metabolic Disturbances in Surgery, M.R.C. Unit, Leeds.)

Cf. *Brit. J. Urology*, **30**, 4, 463 (Dec. 1958); *B.M.J.*, **i**, 740–51 (Mar. 21, 1959)

Dr. W. J. O'Connor.—*The mechanism of the kidney.*

In the glomeruli a filtrate of plasma is formed which is mostly reabsorbed in the renal tubules. Mechanisms involved in these processes will be discussed with particular reference to sodium, and in the light of recent microscopic observations.

(Senior Lecturer in Physiology, Leeds U.)

Dr. M. Ginsburg.—*Endocrine regulation of renal activity.*

Hormones of the adrenals and pituitary influence the renal excretion of water and salts. Their secretion from glands is affected by slight changes in body-fluid composition. Their renal effects correct the changes which induce their secretion. Thus, endocrine glands are involved in the main function of the kidneys, maintenance of body-fluid composition within narrow limits.

(Lecturer in Pharmacology, Bristol U.)

Cf. 'Antidiuretic hormone in adrenalectomised rats', *J. Endocrinol.* **11**, 165 (1954); 'The effects of haemorrhage and hypertonicity on the neurohypophysis', *Colston Papers*, **8**, 109 (Ginsburg and Brown, 1957).

Wednesday, September 9

Physical education. (*Joint session with Section L (Education)*):

Mr. R. St. G. T. Harper.—*Introduction with references to main developments and trends of the past ten years.*

Physical education as an integral part of education as a whole; its relationship with other aspects of education. The extension of the scope of the subject from simply gymnastics and games to embrace many forms of physical activity.

(Senior Lecturer and Director of the Dept. of Physical Education, Manchester U.)

Mr. A. D. Munrow.—*The application of mechanics to physical skills and activities.*

Mechanics, aesthetics, physiology and psychology all play their part in the learning and performance of physical skills. An understanding of mechnical laws gives some insight into the basis of optimum performance. Skills are classified according to the major mechanical problems they present and a mechanical examination of one group of skills is undertaken.

(Director of Physical Education, Birmingham U.)

Miss Ruth Foster.—*The analysis of movement—a current conception and the reasons for it.*

Attempts to provide a general education in movement have led to various modes of analysis. Reference will be made to these, but the main part of the paper will be concerned with a discussion of the analysis evolved by Rudolf Laban and of its relevance to education today.

(Staff Inspector for Physical Education, Ministry of Education.)

Dr. W. F. Floyd.—*Patterns of muscle activity in movement and posture.*

Electrical potentials can be recorded from contracting muscles; a relaxed muscle is electrically silent. This is the basis of the electromyographic method of studying muscle activity in movement and posture. Simultaneous recordings

from several muscles show patterns of co-operative action. This can be studied in the intact individual without significant interference with movement or posture. The patterns and timing of muscle activity can be related to mechanical aspects of movement, to other external events, and information obtained about 'muscle tone'.

(Senior Lecturer in Physiology, Middlesex Hospital Medical School. Consultant Physiologist to the G.P.O.)

SECTION J

PSYCHOLOGY

Thursday, September 3

THE LISTER LECTURE by Mr. D. E. Broadbent on *Time to react.*

Measurement of the time between the occurrence of a signal and of the response to it tells us about the nervous mechanism which underlies decision. There will be described the background and results of some experiments of this type on reaction to speed.

(Director, Applied Psychology Unit of the M.R.C., Cambridge.)

Prof. P. E. Vernon.—*Intelligence and racial differences.*

Intelligence is a product of genetic potentiality and environmental stimulation: hence strong cultural influences in most of the reported national and racial differences. The evidence suggests real genetic differences in certain aspects of intelligence, but there is much overlapping between such different groups as negroes and whites, no universal inferiority.

(Professor of Educational Psychology, University of London Institute of Education.)

Cf. 'Race and intelligence', *The New Scientist,* (22 Jan. 1959); *Eugenics Rev.* **51,** 99–101 (1959).

Mr. Alec Rodger.—*Fifteen-plus: another problem.*

Discussions on the eleven-plus educational problem have drawn attention away from the fifteen-plus occupational one. This is entering a new phase, through the growth of 'the bulge'. It will be argued that our arrangements for dealing with this young-worker problem are poor; and that their weakness arises from widespread ideas that vocational guidance is unnecessary or useless or undesirable.

(Reader in Psychology in the University of London, Birkbeck College.)

Papers on chance and probability:

Dr. J. Beloff and Mr. K. Warwick.—*Wishful seeing in a gambling situation.*

The subject has first to bet on which symbol will next be flashed on to a screen and then to report which symbol he in fact saw. His responses are analysed in the light of the controversial problem of 'autism'—that is the influence of desire on perception.

(Lecturer and student in Psychology (respectively), Queen's University, Belfast.)

Prof. J. Cohen.—*The psychology of luck.*

The belief in luck, chance or fortune has everywhere and always acted as a powerful influence in human affairs, social and personal. After considering the scope of this belief, experiments will be described which reveal quantitatively the pattern of its effect on a person's expected achievement in a variety of situations.

(Professor of Psychology, Manchester U.)

Dr. W. Mays.—*Chance and uncertainty.*

Most studies of probability have been largely concerned with the mathematics of the subject. In recent years psychologists and others have become interested in the more pragmatic aspects of probability—in our assessment of chances in uncertainty situations. The paper will examine this approach.

(Senior Lecturer in Philosophy, Manchester U.)

Friday, September 4

Papers on perception:

Mr. R. B. Joynson.—*A report of some constancy experiments.*

The report gives the main findings of some experiments, published and unpublished, on the constancies of size and shape carried out at the University of Nottingham. The main aim is to describe the different types of judgement and attitude which have been found.

(Lecturer in Psychology, Nottingham U.)

Dr. C. I. Howarth.—*The functioning of the light-adapted eye.*

The dark-adapted eye is chiefly notable for its extreme sensitivity. The light-adapted eye sacrifices sensitivity to achieve greater spatial and temporal acuity. Some consequences of the way this is achieved will be discussed and some new experiments, on the effects of short flashes of light, reported.

(Lecturer in Psychology, Hull U.)

Dr. D. MacC. MacKay.—*Illusions as clues to perceptual mechanisms.*

To study the normal by way of the abnormal can be dangerous; but by discovering how normal perceptual mechanisms can be 'tricked' one can learn much about the principles on which they function. Examples of informative optical illusions, some old, some new, will be shown.

(Lecturer in Physics, King's College, London.)

Cf. *M.I.T. Symposium on sensory communication, 1959* (1960); *Nature*, **180**, 849–50, and 1145–6 (1957), **181**, 362–3 and 507–8 (1958).

PRESIDENTIAL ADDRESS by Prof. Magdalen Vernon on *Perception, attention and consciousness.*

(Professor of Psychology, The University, Reading.)

Dr. W. A. Belson.—*Television and family life.*

This will be a description of the effects of television upon family life. It will deal with (i) the role of television in family life; (ii) the use made of the set; (iii) the effect of television in keeping family members together at home, with special reference to children and young people; (iv) television's impact on the emotional and intellectual unity of the family.

(Research Fellow in Survey Psychology, L.S.E.)

Cf. 'Effects of television on the interests and initiative of adult viewers in Greater London', *Impact, The Australian Quarterly, Ariel* (*BBC Journal*), *Brit. J. Psych.* **50** (2), 145–58 (May, 1959); 'Learning and attitude changes resulting from viewing a television series, "Bon Voyage"', *Brit. J. Ed. Psych.*, **26**, (1), 31–8 (1956); 'A technique for studying the effects of a television broadcast', *Applied Statistics*, **5** (3), 195–202 (1956); 'Selective perception in viewing a television broadcast', *Audio-Visual Communication Review*, **6** (1), 23–32 (1958); 'The effects of television on cinema going', *Audio-visual Communication Rev.* **6** (2), 131–9 (1958).

Mr. W. Isbister.—*Can interviewing be taught?*

The speaker will look back over four years' work of teaching people to interview. Although the views which he puts forward, based mainly on observation and reflection, are his own, he suggests that if his findings are true they have a number of wider implications.

(Member of Scientific Staff of National Institute of Industrial Psychology.)

Miss E. M. Johns.—*The age factor in reading retardation.*

A survey in York infants' schools, made originally to detect educationally subnormal pupils, has continued during thirteen years with changed emphasis. Examination of over thirteen hundred backward readers confirms findings of other workers. Results suggest, however, that age at time of transfer to junior departments is a factor contributing to retardation.

(Educational psychologist, City of York Local Education Authority.)

Monday, September 7

Papers on mental health:

Dr. W. A. Bowen.—*The York pattern of lunacy practice.*

A survey of the methods and motivations of the treatment of mental illness in York during the past two centuries: showing a repetitive pattern of performance still developing.

(Consultant psychiatrist, the County and City hospitals, York.)

Dr. J. Tizard.—*The residential care of mentally handicapped children.*

Ordinary children, deprived of normal home life, are fostered or placed in small residential homes. Many mental defectives might also be better placed in small homes rather than in large institutions. The experience of running a residential nursery for sixteen mentally handicapped children aged 5 to 10 will be described.

(Psychologist, M.R.C. Social Psychiatry Research Unit, Institute of Psychiatry, London.)

Extended version expected to appear in *Lancet* or *B.M.J.*

Cf. N. O'Connor & J. Tizard, *The Social Problem of Mental Deficiency* (Pergamon Press, London, 1956).

Dr. Alan D. B. Clarke.—*The effects of early deprivation.*

Deprivation is important not only in its own right as a vast world-wide problem but also in the general context of theories of personality development. This paper evaluates the experimental literature with particular reference to individual differences in susceptibility to, and recovery from, the effects of different types of deprivation.

(Consultant psychologist, The Manor Hospital, Epsom, Surrey.)

Papers on communicating science to the layman:

Prof. G. P. Meredith.—*The communication of scientific concepts.*

A theoretical and experimental study of the relation between the logical design of scientific documents and their comprehensibility, with some reference to the problems of scientific writers and readers and to problems of documentation.

(Professor of Psychology, Leeds U.)

Mr. T. M. Higham.—*Communicating the findings of psychological research in industry.*

A psychological department has to get itself accepted by both management and workers before it can make a useful contribution to the firm. Research therefore needs to be planned with a view to satisfying the sometimes conflicting demands of technical competence, administrative convenience and company policy.

(Chief Employment Manager, Rowntree & Co. Ltd.)

Submitted to *Occupational Psych.*

Cf. 'Basic psychological factors in communication', *Occupational Psych.*, **31**, (1), 1–10.

Mr. John Maitland and Prof. W. Jolly.—*The use of information.*

An extension of information theory into the fields of advertising. Attention is drawn to the application of analytical techniques used in communication engineering, in the analysis of advertising campaigns. The subject throughout is treated as an exercise in the communication of information.

(Mr. Maitland is Managing Editor, English Universities Press; Prof. Jolly is Professor of Physics, Royal Naval College, Greenwich.)

Tuesday, September 8

Papers on psychology and arts:

Dr. H. D. Wing.—*A tape revision of the Wing musical aptitude test.*

With the increased availability of good quality tape recorders in secondary schools, a demand has arisen for a tape version of the musical aptitude test. A revised version was therefore prepared as a result of an item analysis of the answer papers of the National Youth Orchestra. The test was made somewhat shorter, standardised, and the validity and reliability reassessed.

(Principal, City of Sheffield Training College.)

Mr. J. N. Britton.—*A study of responses to poetry on the part of adolescents and adults.*

The satisfaction derived from reading poetry is generally regarded as valuable: yet it is found that much of this satisfaction is peculiar to the individual. This paper deals with some attempts to throw light upon the common elements in individual response to poetry.

(Senior Lecturer, University of London Institute of Education.)

Cf. 'Evidence of improvement in poetic judgment', *Brit. J. of Psych.* General Section, XLV, Part III (Aug. 1954).

Miss M. M. Lawlor.—*A comparison of the preferences of young children and adults in decorative design.*

The paper reports the results of a series of investigations into the preferences of children and adults for a set of black and white designs. It is found that the preferences of five-year-old children differ little from those of adults. Findings are related to a previous cross-cultural study, and the psychological implications are discussed.

(Lecturer in Psychology, Bedford College, London.)

Mr. R. G. A. Stretch.—*An experimental investigation of curiosity and exploratory behaviour.*

Several recent investigations in the field of comparative psychology have shown that the rat will manifest extensive exploratory activity when placed in a novel environment. Berlyne (1950, 1955) has hypothesised that the decline in exploratory behaviour following continued exposure to novel stimuli, can be deduced from Hull's Two-Factor Theory of inhibition (1943). In this short paper, the results of certain experiments, designed to test predictions from this theory, will be reported.

(Demonstrator, Psychological Laboratory, Sheffield U.)

Mr. P. B. Humphrey.—*The visibility of moving objects.*

There is often the need to detect the presence of moving and stationary objects when visibility is poor and when they are not always in the centre of the visual field. An experiment investigating these effects is described and some implications of the results, in terms of everyday life, are discussed.

(Senior Psychologist, Army Operational Research Group.)

Dr. C. Poulton.—*Fatigue and boredom in an inspection task.*

The aim was to determine whether there is an optimal range of complexity, over which deterioration in performance with time is minimal. Beyond this optimal range, where the task is either too complex (soon producing 'mental fatigue'), or too simple (soon producing 'boredom'), greater deterioration may be expected.

(Assistant Director, M.R.C. Applied Psychology Research Unit.)

To appear under title, 'The optimal perceptual load in a paced auditory inspection task', *Brit. J. Psych.* (1960).

SECTION K

BOTANY

Thursday, September 3

The PRESIDENTIAL ADDRESS on *Plants on land and in the oceans* read by Dr. C. P. Spencer.

DARWIN LECTURE by Dr. R. G. West on *The Ice Age.*

An account of the history of British vegetation during the Quaternary Ice Age, indicating the relation of the vegetation to the climatic changes during the cold glacial and warmer interglacial periods, and the effects of climatic and geographical changes of the Ice Age on the evolution of the British Flora.

(University Demonstrator in Botany, Cambridge.)

Friday, September 4

Plant movement:

Sir Nigel Ball.—*The phototrophic response of grass seedlings.*

Bending of the coleoptile of grass seedlings in reponse to unilateral illumination is usually attributed to a difference in concentration of growth substances on the two sides, but the way in which this difference is brought about is uncertain. The problem will be discussed in the light of recent evidence.

(Special Lecturer in Botany, University of London, King's College.)

Mr. G. H. Banbury.—*Some tropisms of fungal hyphae.*

A discussion of the curvature produced in growing fungal hyphae by unilateral illumination, gravity and various chemical stimuli such as volatile mating hormones. The problems of perception, growth regulation and directional response in hyphae exhibiting spiral apical growth (involving rotation of the expanding cell wall near the tip) will be outlined.

(Lecturer in Plant Physiology, Durham Colleges, Durham U.)

Mr. A. D. Greenwood.—*Protoplasmic movements in plants.*

Examples of the types of active locomotion of plant cells displayed by the reproductive units of certain algae and fungi equipped with flagella of various kinds. The structure of flagella and the protoplasmic movements involved in their development will be discussed. The paper will be illustrated with a short film and slides demonstrating movements and electron micrographs of fine structure.

(Lecturer in Botany, Leeds U.)

Coastal erosion and coast protection. (*Joint session with Section E (Geography)*) *For full references see entry under Section E*

Professor J. A. Steers.—*Introduction.*

Dr. M. C. Pearson.—*The biology of the sea buckthorn* (Hippophaë rhamnoides *L.*).

The past and present distribution of the plant. An account of the environment in which the plant grows, with particular reference to the substrate in which the plant is rooted. The floristics and structure of the community in which the plant occurs. Problems concerning the reproduction of the plant. Germination experiments.

(Lecturer, Nottingham U.)

Mr. R. K. Gresswell.—*Coast erosion and coast protection in Lancashire.*

Almost the entire coast of Lancashire is in boulder clay, sand, or other unconsolidated deposits and its continued existence is only possible because of the small waves on the Irish Sea. Both erosion and accretion occur juxtaposed and much control has been engineered in certain areas.

(Special Lecturer in Geography, Liverpool U.)

Mr. C. Kidson.—*The uses and limitations of vegetation in shore stabilisation.*

On a relatively short stretch of our coasts vegetation can be used as the sole defence against erosion. On a much longer stretch vegetation can be used in support of protective structures. Examples of the use of different types of vegetation and the stabilisation of differing shores (mud, sand, shingle) are given.

(Head of Coastal Physiographical Research Unit, Nature Conservancy.)

Mr. G. Cole.—*The use of certain plants as stabilisers of marine sediments.*

A review of the experience of some sea defence engineers and others in the use of various grasses and other plants to stabilise wind-borne sand and waterborne silt, and of some possible future developments.

(Civil Engineer, Ministry of Agriculture, Fisheries and Food.)

Monday, September 7

Genetics and the origin of species. (*See entry under Section D*).

Tuesday, September 8

The Yorkshire flora and fauna and its conservation. (*Joint session with Section D (Zoology), in Section D's room*):

Cf. E. A. Spaul, contributions to *The Naturalist* and *The Natural History of the Scarborough District*; E. A. Spaul, *The Advancement of Science* (June, 1955).

Prof. E. A. Spaul.—*Introduction.*

Mr. E. Duffey.—*The management of national Nature Reserves.*

The conservation of plant and animal associations on national Nature Reserves can only be successful if it is based on study of the factors which have influenced the development of these communities and of the special requirements of species of particular interest. Examples to illustrate this will be given.

(Regional Officer, Nature Conservancy, E. Anglia.)

Mr. P. F. Holmes.—*Nature conservation at a Yorkshire Field Centre.*

Malham Tarn is National Trust property, leased to the Field Studies Council, which uses it as a Field Centre and treats the area as a Nature Reserve. The effects of public access and of having large numbers of students will be discussed, together with the possibilities of teaching conservation ideas at Field Centres.

(Warden of Malham Tarn Field Centre since 1948).

Mr. C. J. Smith.—*The work of the Yorkshire Naturalists' Trust.*

County Naturalists' Trusts have an important role in nature conservation. An account will be given of the work of the Yorkshire Naturalists' Trust with special reference to Askham Bog Nature Reserve, and the scope for future activities in Yorkshire will be discussed.

(Senior Science Master, Bootham School, York.)

Dr. W. A. Sledge.—*Botanical aspects of conservation in Yorkshire.*

A survey of the botanical importance of existing nature reserves in Yorkshire and of unconserved areas which merit consideration on grounds of special botanical interest.

(Senior Lecturer, Botany Department, Leeds U.)

General discussion, with concluding remarks by Mr. E. M. Nicholson, C.B.

Semi-popular lecture:

Mr. Wilfrid Blunt.—*The art of botanical illustration.*

An account of the development of the portraiture of plants from the earliest times until the present day.

(Senior Drawing Master, Eton College.)

Cf. *J. Roy. Hort. Soc.*, **LXXVI**, part 4, 118–28 (Apr. 1951); *The Art of Botanical Illustration* (Collins, New Naturalist Series, 1959).

Wednesday, September 9

Marine phytoplankton.

Mr. J. Corlett.—*Phytoplankton from ocean weather stations I and J in the eastern North Atlantic.*

Samples were taken weekly at each station for three years with a fine silk net. A main 'flowering' of diatoms took place in spring and a secondary one in autumn. The timing, size and species composition of the flowerings varied from year to year.

(P.S.O. at Fisheries Laboratory of Ministry of Agriculture, Fisheries and Food at Lowestoft.)

Cf. 'Net Phytoplankton at Ocean Weather Stations I and J', *Cons. Internat. Explor. Mer., Journ. du Cons.* **XIX**, 178–90 (1953).

Dr. R. W. Butcher.—*The nature, distribution and some of the problems of nanoplankton in the sea.*

One very important constituent of the nanoplankton comprises coloured and usually flagellated organisms under 10μ diameter. These have been largely overlooked as they are destroyed on preservation and live a very short time after collecting. They form the food of the larval forms of filter feeding organisms and

doubtless indirectly of the post-embryonic state of many other animals; while some may generate toxic compounds. Although so important, morphologically they are almost unknown. Some new facts about these organisms and their classification are discussed.

(P.S.O., Ministry of Agriculture, Fisheries and Food.)

Dr. C. P. Spencer.—*The effect of concentration of certain essential ions on the growth rate of the marine phytoplankton.*

An investigation of the kinetics of growth of a marine diatom under conditions when the concentration of an essential ion is below the limit of sensitivity of the available analytical methods and the medium is therefore apparently exhausted.

(Lecturer, University College of North Wales, Bangor.)

Dr. J. F. Talling.—*The development and activities of plankton algae in the Nile.*

Dense populations of planktonic algae develop seasonally in various regions of the Nile. Our general knowledge of the factors which govern this development is outlined. Some conspicuous effects of algal activities can be recognised in the modification of physical and chemical properties of the river water.

(Plant physiologist, Freshwater Biological Association, Ambleside.)

Cf. 'Diurnal changes of stratification and photosynthesis in some tropical African waters', *Proc. Roy. Soc. Lond. B*, **147**, 57–83 (1957); 'The longitudinal succession of water characteristics in the White Nile', *Hydrobiologia*, **11**, 73–89 (1957); with G. A. Prowse, 'The seasonal growth and succession of plankton algae in the White Nile', *Limnology and Oceanography*, **3**, 222–38 (1958).

SUB-SECTION K*

FORESTRY

Thursday, September 3

PRESIDENTIAL ADDRESS to Section K

CHAIRMAN'S ADDRESS by Mr. W. R. Day on *The influence of pathogenic factors within the rooting space on the development of even-aged plantations.*

Friday, September 4

The value of forest shelter in agriculture. (*Joint session with Section M (Agriculture)*)

Prof. J. E. Nichols.—*Shelter needs in relation to land use.*

Planted shelter is of value in so far as it may add effectively to that provided by other barriers and ground configuration within the farm area, in relation to exposure risks and hazards. Husbandry systems and critical periods for crops and livestock are factors for consideration in assessing shelter needs.

(Professor of Agriculture: Animal Husbandry, U.C., Aberystwyth.)

Dr. J. M. Caborn—*The planning of shelterbelts: design and structure*

Certain new principles to be observed in shelterbelt planning and design have emerged from recent work. On arable farms the maintenance of an appropriate structure is important. Other factors may influence the design and subsequent management of hill shelterbelts and involve changes in sheltering efficiency as the structure develops.

(Research Officer, Ministry of Agriculture Livestock Shelter Research Programme, U.C., Aberystwyth.)

To appear in *Forestry*.

Cf. 'Shelterbelts and microclimate', *Forestry Commission Bulletin 29*, H.M.S.O. (1957).

Mr. D. T. Michael.—*Some aspects of shelter in relation to the grazing animal.*

The basic concept of animal existence has been stipulated as the search for food, reproduction and attempted preservation. Preservation among other

things requires shelter; for stress, the current malady of the higher animal, afflicts also the lower order. Some field aspects of this problem, shelter, are described.

(Veterinary Officer.)

Cf. *Veterinary Record*, **65**, No. 24 (1953); *Ibid.* **69**, No. 24 (1957); *State Veterinary J.* **10**, No. 30 (1955), **11**, No. 33 (1956).

Monday, September 7

Deer in Britain. (*Joint session with Section D (Zoology)*)

Mr. G. Kenneth Whitehead.—*Red deer in Britain* (film and paper).

Wild red deer *Cervus elaphus* are well distributed in the Highlands and islands of Scotland. They also occur in a few localities in England and Ireland, but the species no longer exists in Wales. The paper describes the status and distribution of red deer in the British Isles, and also gives views on the red deer population.

Cf. 'Taking stock of red deer", *Country Life* (Dec. 12, 1952); 'Why no close season?' *Country Life* (Dec. 9, 1954); article on Scotland's red deer population to appear in *The Field*, Oct. or later 1959; *Deer and their Management* (Country Life); *Ancient White Cattle of Britain* (Faber); *The Stalking Grounds of Great Britain and Ireland* (Hollis and Carter, in the press).

Mr. J. S. R. Chard.—*Damage by roe deer, and methods of protection.*

The nature, incidence and significance of damage by roe deer to forest crops, and methods of protection based on the modification of current silvicultural and management practice.

(Conservator of Forests, North-west England.)

Mr. H. A. Fooks.—*The roe deer.*

Annual life cycle. The necessity of knowing their habits before successfu control can be effective. Necessity of control. Importance of scent glands i their life.

(Game Warden, Forestry Commission.)

Tuesday, September 8

Work study:

Professor Ulf Sundberg.—*Physiological research on forest works as an aid to increased efficiency and improved working methods.*

A brief description of the physiological research methods employed, the information they give and fail to give. Examples of research will be demonstrated as well as the practical application of the results.

(Head of the Department of Operational Efficiency, Swedish Forest Research Institute, Stockholm.)

Mr. J. W. L. Zehetmayr.—*Work study in British forestry.*

A brief account of the principles of work study, i.e. method study and work measurement, showing how they have been applied to the marking, felling, extraction, conversion, and despatch of timber from thinning operations in young coniferous stands.

(Work study officer, Forestry Commission.)

Mr. R. E. Crowther.—*The extraction of thinnings by horse.*

Work study has thrown light on the various methods of extracting thinnings by horse. The effect on output of length of haul and pole size are discussed, and costs for certain conditions given.

(District (Forest) Officer, Forestry Commission, Work Study Section.)

Wednesday, September 9

Decay in standing trees:

Dr. W. P. K. Findlay.—*Heart rots of standing trees; their recognition and significance.*

The bark of living trees provides a barrier against infection. The fungi that cause heart rots enter through wounds or diseased roots. Detection of rot in standing trees is often difficult and the condition is often revealed only on felling.

Definite identification of the causal fungi may depend on preparation of pure cultures of the fungus. Top rots cause losses in over-mature trees; butt rots may be responsible for serious losses in young conifer plantations.

(Assistant Director of Brewing Industry Research Foundation.)

To appear in *Quart. J. For.* (Apr. 1960).

Mr. J. D. Low.—Fomes annosus *in Britain.*

An account of its infection biology, of factors affecting its spread and increase in old conifer forests, and its establishment in newly afforested areas. A discussion of measures of disease control.

(Field Assistant to Forest Pathologist, Forestry Commission.)

Mr. H. G. Dowden.—*Decay as a source of economic loss in spruce.*

A description of some preliminary investigations into the distribution of decay caused by *Fomes annosus* (Fr.) Cke. in spruce stems. An outline of some attempts made to assess the actual volume loss from this source and the future wastage during conversion caused by the decay.

(Assistant Lecturer in Forestry, Aberdeen U.)

SECTION L

EDUCATION

Thursday, September 3

Science and mathematics in the three-year teacher training course:

Mr. A. Keith.—*The training college and science and mathematics.*

A consideration of the place and value of science and mathematics in the training college curriculum and of the various courses which may have to be provided in these subjects.

(Principal, Stranmillis Training College, Belfast.)

Dr. K. Laybourn.—*The training of teachers of science and mathematics: what the schools require.*

The training of teachers of science and mathematics considered in relation to the objectives and methods of teaching these subjects in schools, with particular reference to three-year Training College courses. A plea for a radical change of outlook.

(Chief Inspector of Schools, Bristol.)

Friday, September 4

PRESIDENTIAL ADDRESS by Sir James J. Robertson, O.B.E., on *What are our schools for?*

(Rector of Aberdeen Grammar School.)

Dr. Douglas M. McIntosh.—*The pool of ability.*

An assessment of the importance of educated manpower in modern industrialised societies, an estimate of the potential size of the pool of ability, and a discussion of the ways of increasing the number of entries into it.

(Director of Education, Fife.)

Scottish Educational J. (Sept. 11, 1959).
Cf. *Educational Guidance and the Pool of ability* (L.U.P., 1959).

Monday, September 7

Science and number in the primary school:

Mrs. E. C. Mee, C.B.E.—*The primary school today.*

During the last fifteen years there have been great changes in primary education, and some remarkable achievements. These changes are part of a continuously developing process. What is the nature and direction of this development? What aspects of it seem most promising for the future? Where is it falling short of the children's needs?

(Formerly H.M.I.; Chief Inspector for Primary Education, Ministry of Education.)

Mr. N. F. Newbury.—*Science in the primary school.*

The scope of science must be extended to include physical science. Methods involving solving problems and discovery are recommended. The material should be based on the children's interests and linked with home, school and the near environment. The teacher's main problem is to arrange experiences appropriate to each child's needs.

(Director of Education, St. Helens.)

Mr. L. G. W. Sealey.—*Number in the primary school.*

Consideration of the creation of mathematical learning situations in the primary school which are appropriate to the needs of children as developing individuals, and through which their mathematical ability may be caused to grow and their attitudes to this area of learning made positive.

(Advisory Officer for Junior Schools, Leicestershire.)

Tuesday, September 8

A symposium on the organisation of secondary education:

Mr. G. H. Bantock.—*The organisation of secondary education.*

Some reasons for the current interest in the organisation of secondary education. The implications of the present tripartite system. A consideration of a number of alternative schemes of organisation and a brief attempt to assess their work. Recommendations and conclusion.

(Reader in Education, Leicester U.)

Cf. 'Tripartite reform', *Times Ed. Supp.* (Mar. 7 and 14, 1958).

Dr. R. Pedley.—*The organisation of secondary education.*

A review of the controversial problems which stir both Britain and North America today—and suggestions for their solution.

(Senior Lecturer in Education, Leicester U.)

Extract in *Education*, p. 358 (Sept. 11, 1959).

Cf. *Comprehensive Schools Today* (Councils and Education Press, 1955); *Comprehensive Education: A New Approach* (Gollancz, 1956); 'Reform in higher education', *Times Ed. Supp.* (Sept. 9, 1944); 'County College and Sixth Form', *Education* (Feb. 18 & 25, 1949); 'Comprehensive education', *Schoolmaster*, pp. 599–606 (Apr. 8, 1955); 'The way ahead', *Schoolmaster*, pp. 719–20 (Nov. 23, 1956); 'The secondary schools: a middle way', *Manchester Guardian* (Jan. 19, 1957); 'Comprehensive chain', *Times Ed. Supp.* p. 737 (May 24, 1957); 'Ending Eleven-Plus', *New Statesman*, pp. 663–4 (May 24, 1957); 'Lord Hailsham's legacy', *Journal of Education*, pp. 4–5 (Jan. 1958); 'The effect of the size of the school', *1958 Year Book of Education*, Section III, Ch. 6, pp. 339–48; 'New schools for 1970', *Observer* (May 11, 1958); 'The organisation of secondary education', *Report of 12th Annual Conference of the National Association of Divisional Executives in Education*, pp. 55–72 (1958); 'Die Comprehensive School in England', *Schule und Nation*, pp. 15–17 (Oct. 1958); 'The choice before us', *Times Ed. Supp.*, p. 209; (Feb. 6, 1959) 'Two-tier secondary education: the latest phase', Chapter 7 in *Changing Schools*, ed. Blishen (Council for Children's Welfare, 1959); 'Lessons from Canada', *Education*, pp. 9–10 (July 3, 1959); 'Report from Yorkshire', *Forum*, pp. 22–7 (Sept. 1959).

Wednesday, September 9

Physical education. (*See entry under Section I.*)

Visual aids in the teaching of science:

Dr. J. A. Harrison.—*The contribution visual aids can make.*

The contribution of visual aids to the teaching of science with special reference to the film and to the technique which it provides.

(Director, National Committee for Visual Aids in Education.)

Miss Enid Love.—*Television's place in the teaching of Science.*

A survey of what has been attempted in Britain in this field by both the B.B.C. and I.T.A. A comparison with experiences in other countries, particularly in the U.S.A. Possible developments in the future, in primary schools, in sixth forms and in relation to the present shortage of science teachers.

(Head of School Broadcasting, Associated-Rediffusion Ltd.)

SECTION M

AGRICULTURE

Thursday, September 3

PRESIDENTIAL ADDRESS by Dr. H. G. Sanders on *Balance in British farming*.

(Chief Scientific Adviser—Agriculture, Ministry of Agriculture, Fisheries and Food.)

Problems of small farms:

Mr. D. B. Wallace.—*Problems of the small arable farm.*

An examination of the relative inputs and output of small and large arable farms in defined areas, the consequences of any differences and a possible course of future policy for the maintenance of income amongst the smaller farms.

(Senior Research Officer, Farm Economics Branch, Cambridge U.)

Cf. 'Planning small farms for profit', *Occasional Paper No. 7* (Farm Economics Branch, School of Agriculture, University of Cambridge) (in the press).

Mr. E. A. Attwood.—*Small farm problems: livestock and dairying.*

Livestock and dairy farms of under 100 acres account for two-thirds of our total full-time farms. The wide variations in the profitability and economic efficiency of these farms is related primarily to the intensity of their production and the managerial ability of the farmer.

(Lecturer in Agricultural Economics, Univ. Coll. of Wales, Aberystwyth.)

Friday, September 4

The value of forest shelter in agriculture. (*See entry under K**.)

Meat:

Mr. W. E. Bowden.—*Quality and marketing of meat.*

The breeding, production and marketing of meat should have a common linkage of purpose related to efficient and economic production to suit marketing requirements. The paper suggests that a close understanding between pedigree breeders, commercial producers and marketing is desirable and that further advancements in quality meat production depend upon the adoption of new techniques based upon reliable research developments.

(Head of Livestock Division, the Fatstock Marketing Corporation Ltd.)

Mr. R. A. Mackness.—*Economics of meat production.*

This paper discusses the economics of meat production with particular reference to least-cost methods of production, related to the seasonal pattern of prices.

(Senior Research Officer, Farm Economics Branch, Cambridge U.)

Mr. S. Williams.—*Breeding and management for meat.*

As a producer I recognise that the meat production on my farm must be designed for profit, using what I can produce or buy cheaply. I must provide animals that the butcher or processor will handle profitably himself as he passes the bits on to satisfied customers. They want tender, uniform lean meat. Farm costs can still be reduced by intensification of scientifically designed production techniques.

(Head of Messrs. Boots' Farms.)

Monday, September 7

Challenges to agricultural research:

Sir William, Slater, K.B.E., F.R.S.—*Research for agriculture.*

The Agricultural Research Council's place in agriculture; how it tries to fill it. A discussion of some of the more important problems of the industry requiring solution. The way in which these may be approached. What is required for their solution. Problems of the application of the results of research in practice.

(Secretary of the Agricultural Research Council.)

Mr. F. G. W. Jones.—*Plant parasitic nematodes.*

The present state of research on plant parasitic nematodes will be reviewed. Reference will be made mainly to nematode pests of importance in Great Britain but will include some reference to important pests overseas.

(Head of Nematology Department, Rothamsted.)

Dr. J. Deans Rankin.—*The problem of Johne's disease.*

Johne's disease, an infectious enteritis of cattle and sheep, is now nearing the top of the list of diseases causing serious economic loss in our dairy and beef herds. In reviewing the problem the present paper traces the principal steps by which our knowledge of this disease has advanced and illustrates some of the peculiar difficulties encountered. Current trends in Johne's disease research and possible methods of future control are discussed.

(P.S.O., A.R.C., Compton, Berks.)

Tuesday, September 8

Soil tilth and plant populations:

Mr. J. C. Hawkins.—*Cultivations.*

The origin of current problems on soil cultivation and the preparation of seedbeds with tractor equipment, and possible solutions suggested by work on the mode of action of cultivation implements, soil structure and soil aeration.

(Head of Soil Department, N.I.A.E., Wrest Park, Silsoe.)

Expected to appear in *J. Agricultural Engineering Research.*
Cf. *Farmer & Stockbreeder* (Sept. 15, 1959); *Farmers' Weekly* (Sept. 18, 1959).

Mr. R. Holliday.—*Studies on plant populations in relation to crop yield.*

Work at Leeds and other experimental work on plant populations will be reviewed. From the contrasting crops examined evidence is obtained of two forms of yield response curve to plant populations, depending upon whether the yield is a product of vegetative or reproductive growth. The nature of the vegetative response curve will be examined more closely.

(Senior Lecturer in Agriculture—Agronomy and Crop Husbandry, Leeds U.)

Dr. R. S. Edwards.—*Tilths and plant populations.*

Soil was separated into various size fractions by an electrically driven rotary sieve S. 172: oats were sown at three dates in autumn on seedbeds made up of the sieved separates. The variation in over-winter mortality of plants on these seedbeds was studied. This work has led to the development of techniques for measuring frost heaving of soil.

(Lecturer in Agriculture, Univ. Coll. of Wales, Aberystwyth.)

Cf. *Emp. J. Exp. Agric.*, **24**, 317 (1956), **25**, 167, 304, (1957); *J. Agric. Soc. Univ. Coll. Wales*, **38**, 21 (1957).

SECTION X

ASSEMBLY OF CORRESPONDING SOCIETIES

Thursday, September 3

Mr. Patrick Moore.—*Problems of the moon.*

General description of the moon, followed by an outline of some of the problems facing selenographers; the origin of the craters will be discussed, together with reported variations of surface features, the presence or absence of a tenuous atmosphere, and similar matters. An outline of probable future research will be given, and mention made of the present rocket experiments.

(Fellow of Royal Astronomical Society; member of Council of British Astronomical Association.)

Conference of delegates of affiliated societies to be opened by the Countess of Albemarle, D.B.E., President of the Section.

PRESIDENTIAL ADDRESS by the Countess of Albemarle, D.B.E., on *Living with science.*

The problem for the non-scientifically trained person of living in the new world revealed by scientific discovery, of adapting society to the rapid advance of scientific knowledge and of forming political judgements in the light of that knowledge.

(Chairman of the Development Commission, Life Trustee of the Carnegie United Kingdom Trust.)

Friday, September 4

Dr. P. J. Lawther.—*Air pollution and its effects on man.*

The problem of pollution of the air is now being vigorously attacked. The effect of smoke and acids on materials is more readily assessable than their effect on health but air pollution may be one of the most malign factors in man's environment. This communication outlines the complex problems and reviews current research.

(Director, M.R.C. Group for Research on Atmospheric Pollution, St. Bartholomew's Hospital, London.)

Cf. P. J. Lawther & R. E. Waller, 'Some observations on London fog', *B.M.J.* **ii,** 1356 (1955); P. J. Lawther & R. E. Waller, 'Further observations on London fog', *B.M.J.* **ii,** 1473 (1957); B. T. Commins, P. J. Lawther & R. E. Waller, 'Air pollution in diesel bus garages', *Brit. J. Ind. Med.*, **14,** 232 (1957); P. J. Lawther & R. E., Waller, 'Atmospheric pollution and lung cancer', *Trans. Ass. Ind. Med. Off.*, **IX,** 5 (1959).

Mr. P. Ritchie Calder, C.B.E.—*The use and misuse of science.*

People fear the destructive effects of scientific discovery and tend to forget the beneficial. The paper will deal with instances of both and with the responsibilities of scientists as functional citizens.

(Advisor to the United Nations specialised Agencies.)

Brigadier E. F. E. Armstrong.—*The scope and problems of a volunteer conservation corps.*

The scope and problems of a volunteer conservation corps are discussed, the comments being based on the experience gained in the Conservation Corps of the Council for Nature. Comparisons are made, where appropriate, with the experiences of the volunteer Civilian Conservation Corps, constituted in the United States of America in the 1930's.

(Organiser, Conservation Corps, Council for Nature.)

Mrs. Edrie Green.—*Directing the energies of unstable city 'teenagers' into useful work in a National Park.*

Kyndwr Scwd Mountain Training Group is an experimental project in which 'Teddy Boy' types from the City who will not join a normal youth group are co-opted into a 'gang' that helps farmers, gives mountain training and generally helps the boys to settle in their normal social setting.

(Warden, Kyndwr Scwd Mountain Training Group.)

Monday, September 7

Mr. P. Ritchie Calder, C.B.E.—*New horizons in science.*

Mr. Robert Patterson.—*Wool craftsmanship in York.*

York's position as the second city in England was based largely on wool. Great skill was required to convert wool to high-grade cloth with the equipment available, and this old equipment is brought into service to demonstrate the handcrafts involved.

(Curator, Castle Museum, York.)

Tuesday, September 8

Science by the upper form:

Mr. M. L. M. Wright.—*Physiography and scenery of the Isle of Eigg.*

An account of the evolution of a landscape, and a synopsis of some work done on a recent visit to the Isle of Eigg.

(Scholar of Ampleforth College, York.)

Mr. A. N. P. Butland and Mr. P. A. Crossley.—*Some scientific aspects of the River Ouse.*

The results of extended quantitative and qualitative analysis of various samples of the Ouse water, and the methods used to obtain them (Butland). The surface tension of the river water; factors influencing this, and effects produced by its reduction (Crossley).

(Scholars of St. Peter's School, York.)

Mr. Shaun Firth.—*Sedges of Askham bog.*

A study of the mosses at Askham Bog, an area of fenland near York (excluding species epiphytic on trees). An attempt will be made to correlate the variable nature of the habitat, especially soil conditions, with the distribution of the moss species in a restricted locality.

(Scholar of Bootham School, York.)

Miss Nancy G. Proctor.—*Roman York*

An account of how a non-expert observer has been able to enlarge her knowledge of Roman York through observation of archaeological researches in progress, with special reference to one excavation. The account will be illustrated by maps and slides.

(Scholar of Bar Convent Grammar School, York.)

Miss Eileen Burton and Miss Joanne Littlefair.—*The seasonal rhythm and behaviour of the birds of Bempton Cliffs.*

The communication has been compiled during the last year by a small group of bird watchers from Bridlington High School. It consists of an illustrated account of the birds, their behaviour, seasonal activities and relative numbers, and their relationship with the geology and topography of the cliffs.

(Scholars of the High School for Girls, Bridlington, Yorks.)

OFFICERS FOR THE YORK MEETING

September 2–9, 1959

LOCAL OFFICERS

CHAIRMAN OF THE LOCAL EXECUTIVE COMMITTEE
THE RT. HON. THE LORD MAYOR

VICE-CHAIRMEN OF THE LOCAL EXECUTIVE COMMITTEE
Councillor J. DURKIN, Mr. J. DRONFIELD

LOCAL HON. SECRETARIES
Mr. T. C. BENFIELD, Mr. H. OLDMAN

LOCAL HON. TREASURER
Mr. B. LITTLEFAIR

LOCAL ASSISTANT SECRETARIES
Mr. P. COOKE, Miss B. CLARKSON

HON. ACCOMMODATION OFFICER
Mr. R. DOHERTY

HON. EXCURSIONS OFFICER
Mr. A. COOKE, M.B.E.

HON. TRANSPORT OFFICER
Mr. H. N. TUFF

HON. PRESS OFFICER
Mr. C. H. RULE

MEMBERS OF THE COMMITTEE

THE SHERIFF OF YORK, THE VERY REVEREND THE DEAN OF YORK, THE PRESIDENT OF YORK CHAMBER OF TRADE, THE CHAIRMAN OF YORK & DISTRICT TRADES COUNCIL, Alderman R. SCRUTON, J.P., Councillor J. DURKIN, THE PRINCIPAL OF ST. JOHN'S COLLEGE, THE HEADMASTER OF ST. PETER'S SCHOOL, THE PRESIDENT OF YORK HEADTEACHERS' ASSOCIATION, G. F. WILLMOT, Esq., A. S. RYMER, Esq., O.B.E., J.P., A. NORTON, Esq., H. BELL, Esq., A. D. GLADWIN, Esq., J.P., G. R. HARDACRE, Esq., Alderman E. L. KELD, J.P., Councillor A. L. PHILIPSON.

SECTIONAL OFFICERS

A.—MATHEMATICS AND PHYSICS

President.—Prof. L. F. BATES, F.R.S.
Vice-Presidents.—Prof. W. T. ASTBURY, F.R.S., Prof. G. F. J. GARLICK, Mr. N. E. ROWE, C.B.E., Prof. E. C. STONER, F.R.S., Dr. E. WILFRED TAYLOR, C.B.E., F.R.S.
Recorder.—Miss M. V. GRIFFITH, E.R.A. Laboratories, Cleeve Rd., Leatherhead, Surrey.
Secretaries.—Dr. A. D. BOOTH, Prof. D. N. de G. ALLEN (*Maths. A**).
Local Secretaries.—Mr. E. K. ROBINSON, Miss F. B. KORDIK.

B.—CHEMISTRY

President.—Prof. M. STACEY, F.R.S.
Vice-Presidents.—Mr. G. H. BEEBY, Prof. N. B. CHAPMAN, Prof. E. G. COX, F.R.S., Prof. F. S. DAINTON, F.R.S., Dr. ROWLAND HILL, Prof. B. LYTHGOE, F.R.S., Mr. J. C. H. MCENTEE, Mr. A. NORTON, Mr. S. W. SAUNDERS, Dr. CAMERON WALKER, Mr. W. J. V. WARD.
Recorder.—Dr. I. J. FAULKNER, Parkhurst, Eaglescliffe, Stockton-on-Tees.
Secretaries.—Prof. W. G. OVEREND, Dr. BERNARD ATKINSON.
Local Secretaries.—Mr. R. T. E. ALLEN, Mr. A. F. THOMSON.

C.—GEOLOGY

President.—Prof. O. M. B. BULMAN, F.R.S.
Vice-Presidents.—Mr. W. ANDERSON, Mr. W. S. BISAT, F.R.S., Prof. K. C. DUNHAM, F.R.S., Mr. W. N. EDWARDS, Mr. S. MELMORE. Prof. H. C. VERSEY.
Recorder.—Dr. C. R. K. BLUNDELL, University College, Newport Rd., Cardiff.

Secretaries.—Dr. A. E. CURRALL, Dr. DOUGLAS A. BASSETT.
Local Secretary.—Mr. JOHN DOSSOR.

D.—ZOOLOGY

President.—Dr. L. HARRISON MATTHEWS, F.R.S.
Vice-Presidents.—Prof. P. G. 'ESPINASSE, Prof. A. D. HOBSON, Prof. E. A. SPAUL, Dr. E. WILFRED TAYLOR, C.B.E., F.R.S.
Recorder.—Prof. E. J. W. BARRINGTON, Department of Zoology, The University, Nottingham.
Secretary.—Mr. P. F. MATTINGLY.
Local Secretary.—Mr. C. J. SMITH.

E.—GEOGRAPHY

President.—Prof. K. C. EDWARDS.
Vice-Presidents.—Mr. C. CHAPMAN, Prof. R. E. DICKINSON, Prof. E. ESTYN EVANS, Prof. H. R. WILKINSON.
Recorder.—Prof. M. J. WISE, London School of Economics, Houghton St., London, W.C.2.
Secretaries.—Dr. J. W. BIRCH, Mr. N. STEPHENS.
Local Secretaries.—Mr. A. HURWORTH, Mr. R. O. SMITH.

F.—ECONOMICS

President.—Prof. J. JEWKES, C.B.E.
Vice-Presidents.—Prof. A. J. BROWN, Prof. D. T. JACK, C.B.E., Mr. J. F. BLITZ.
Recorder.—Mr. R. L. SMYTH, Department of Economics, The University, Hull.
Secretary.—Dr. E. RUDD.
Local Secretary.—Mr. J. McHUGH.

G.—ENGINEERING

President.—Sir EWART SMITH, F.R.S.
Vice-Presidents.—Mr. R. C. BOND, Mr. G. KITSON, O.B.E., Mr. C. C. INGLIS, Prof. O. A. SAUNDERS, F.R.S.
Recorder.—Prof. J. GREIG, Department of Electrical Engineering, King's College, Strand, W.C.2.
Secretary.—Dr. E. M. DEELEY.
Local Secretary.—Mr. R. KAGAN.

H.—ANTHROPOLOGY

President.—Prof. I. A. RICHMOND, C.B.E., F.B.A.
Vice-Presidents.—Dr. E. A. GEE, Dr. MARGARET MURRAY, Mr. R. PATTERSON, Dr. IORWERTH C. PEATE, The Rev. Dr. PURVIS, Dr. W. A. SINGLETON, Mr. G. F. WILLMOT.
Recorder.—Mr. J. G. HURST, Assistant Inspector of Ancient Monuments, Ministry of Works, Lambeth Bridge House, London, S.E.1.
Secretaries.—Mr. JOHN BARTLETT, Dr. V. B. PROUDFOOT.
Local Secretary.—Mr. H. G. RAMM.

I.—PHYSIOLOGY AND BIOCHEMISTRY

President.—Prof. A. HEMINGWAY.
Vice-Presidents.—Dr. F. L. A. HUGHES, Lady MELLANBY, Dr. E. N. WILLMER.
Recorder.—Mr. B. B. LLOYD, University Laboratory of Physiology, Oxford.
Secretary.—Dr. J. S. GILLESPIE.
Local Secretary.—Dr. CATHERINE B. CRANE.

J.—PSYCHOLOGY

President.—Prof. MAGDALEN D. VERNON.
Vice-Presidents.—Dr. C. C. BERESFORD, Mr. T. M. HIGHAM, Prof. G. P. MEREDITH, Prof. R. W. PICKFORD, Mr. G. WESTBY.
Recorder.—Mr. D. McMAHON, Applied Psychology Research Unit, 39 George Square, Edinburgh, 9.
Secretary.—Mr. D. E. BROADBENT.
Local Secretary.—Miss E. M. JOHNS.

K.—BOTANY

President.—
Vice-Presidents.—Prof. R. S. ADAMSON, Mr. G. L. J. BATTERS, Rt. Hon. Lord BO...TON, Mr. W. R. DAY (*Chairman, K**, *Forestry*), Prof. R. D'O. GOOD, Prof. IRENE MA...TON, Dr. W. A. SLEDGE, Prof. MEIRION TH...MAS, F.R.S.
Recorder.—Prof. C. G. C. CHESTERS, Department of Botany, The University, Notting...ham.
Secretaries.—Prof. L. J. AUDUS, Mr. T. H... OWEN (*K**, *Forestry*), Dr. J. M. THODA...
Local Secretaries.—Mr. D. H. ADAMS, Mr. T. V... DENT, M.B.E. (*K**, *Forestry*).

L.—EDUCATION

President.—Sir JAMES J. ROBERTSON, O.B.E.
Vice-Presidents.—Miss J. H. ASPDEN, Mr. J. ... GREEN, Sir WILLIS JACKSON, F.R.S., Mr. ... KAGAN, The Rev. Canon P. J. LAMB, Pro... W. R. NIBLETT, Mr. H. OLDMAN, Alderma... G. T. ROGERS, Mr. J. TURNER.
Recorder.—Mr. R. G. K. HICKMAN, National Union of Teachers, Hamilton House, Mabledon Place, London, W.C.1.
Secretaries.—Mr. A. E. EVANS, O.B.E., Mr. G. C. E. SMITH.

M.—AGRICULTURE

President.—Dr. H. G. SANDERS.
Vice-Presidents.—Mr. F. BATES, Prof. T. L... BYWATER, Dr. D. C. CUTHBERTSON, C.B.E., Lieut.-Col. Sir JOHN DUNNINGTON-JEFFE... SON, Bt., EARL OF FEVERSHAM, D.S.O., Majo... LE G. G. W. HORTON-FAWKES, Prof. ... McGREGOR, Mr. J. W. REID, O.B.E., Sir WILLIAM WORSLEY, Bt.
Recorder.—Prof. W. ELLISON, Department of Agriculture, University College, Aberystwyth.
Secretary.—Prof. J. D. IVINS.
Local Secretary.—Mr. L. C. G. GILLING.

X.—ASSEMBLY OF CORRESPONDING SOCIETIES

President.—The COUNTESS OF ALBEMARL... D.B.E.
Vice-Presidents.—Rt. Hon. Lord BOYD OR... D.S.O., M.C., F.R.S., Mr. J. DRONFIELD, D... J. B. MORRELL, Dr. W. M. PAGE, Sir HERBE... READ, D.S.O., Mr. F. EDWARDS
Recorder.—Mr. J. A. S. STENDALL, O.B.E. 'Deva', 53 Abbot's Grange, Liverpool Ro... Chester.
Secretary.—Mr. G. S. CAMPBELL.
Local Secretary.—Mr. R. PATTERSON.